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MASSACHUSETTS
AGRICULTURAL COLLEGE

REPORT OF THE PRESIDENT
AND OTHER OFFICERS OF
ADMINISTRATION



1919

THE M. A. C. BULLETIN
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THE FIFTY-SEVENTH ANNUAL REPORT OF THE
MASSACHUSETTS AGRICULTURAL COLLEGE

PART I.—THE REPORT OF THE PRESIDENT
AND OTHER OFFICERS OF ADMINISTRATION
FOR THE FISCAL YEAR ENDED NOV. 30, 1919



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APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

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The Commonwealth of Massachusetts

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Nov. 29, 1919.

To His Excellency CALVIN COOLIDGE.

SIR: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith, to Your Excellency and the Honorable Council, Part I of the fifty-seventh annual report of the trustees, for the fiscal year ended Nov. 30, 1919, this being the report of the president of the college and other officers of administration to the corporation.

I am, very respectfully, your obedient servant,

KENYON L. BUTTERFIELD,
President.

REPORT OF THE PRESIDENT OF THE COLLEGE.

Gentlemen of the Corporation.

I herewith submit my annual report as president of the Massachusetts Agricultural College for the year ending Nov. 30, 1919, and with it transmit reports from other administrative officers of the institution.

REVIEW OF THE YEAR.

The year just closed has been essentially one of readjustment following the abnormal conditions which developed during the war.

Enrollment of Regular Students.

The Students' Army Training Corps was disbanded early in December, 1918. With the beginning of the second term of the college work, after the Christmas holidays, normal conditions began to be resumed. The college took a liberal attitude in making academic adjustments for those students desiring to return to college and continue their work. The registration of the second term up to Feb. 17, 1919, was 384; of these, 343 were enrolled in the four-year course, 12 in the graduate school, and 29 as unclassified students. From time to time, after February 17, a few others enrolled in the four-year course.

The enrollment of students in work of college grade in the autumn of 1919 totals 519, 453 of whom are registered in the four-year course, 33 in the graduate school, and 33 as unclassified students. There are 19 women students enrolled in our four-year course, two in the graduate school, and 9 as unclassified students, making a total of 30 doing work of college grade. The entering class of freshmen numbers 125.

It is gratifying to note that over 100 students enrolled in the four-year course this autumn are those whose college careers were interrupted by the war, and that the majority of these men have returned from overseas service.

Enrollment in the Two-year Course.

The work of our two-year course has met with an enthusiastic response from the people of the State. It will be recalled that the first year of the two-year course started about the first of December, 1918, and continued until the last of March, 1919. At the close of the first year's work in this course, those who had enrolled were placed on farms for six months' practical work. The enrollment in the two-year course this autumn is even larger than was anticipated, the total being 209, of whom 8 are women. Twenty-nine men have registered in special one-year courses in poultry husbandry and in rural engineering.

Summer School and Other Short Courses.

The summer school of 1919 had the largest enrollment in its history, the total being 238. The work of this course was developed in co-operation with the State Department of Education, and served as a training school for teachers of western Massachusetts and for others desiring special work in agriculture.

In the winter of 1919, when it was learned that the army in the American camps would be speedily demobilized, a series of six weeks' courses in agriculture was arranged to meet the need of those soldiers who should care to come to the college for a brief period and more adequately prepare themselves for farm work. These courses started February 10, April 14 and June 30, respectively. A special course in poultry husbandry was offered from March to June, 1919. The ten weeks' course of 1919 was quite well attended, the total enrollment being 63.

The development of our short course work has, under Prof. John Phelan's direction, been most gratifying, and the demand for the various courses already organized has been quite unexpected. I wish to submit in full Director Phelan's report covering this work. (See pages 43-47.)

Federal Board for Vocational Education.

The Federal Board for Vocational Education was, at the close of war hostilities, delegated to assume the responsibility for providing adequate training for those soldiers and sailors

who had been disabled during the war. The officers of this Board, who have charge of the New England district, chose the Massachusetts Agricultural College to which should be sent those disabled soldiers and sailors desiring to pursue an agricultural course in order to adequately fit themselves for a vocation which will render them self-supporting. A few of these returned soldiers and sailors were enrolled in the college in the spring of 1919, and this autumn some 75 are here. A few of these are enrolled in our four-year course, three or four being former students of this institution; but nearly all of the Federal Board men are enrolled in the two-year course.

Total Enrollment at the Present Time.

In addition to the 519 students enrolled in the work of college grade, we have on the campus at the end of November, 209 in the two-year course, and 29 in the one-year courses in poultry husbandry and rural engineering, making a total of 238 in our short courses, and a total student population of 757.

Student Activities.

All varsity athletic teams have now resumed intercollegiate relations on much the same basis as that prevailing before the war. The baseball team of 1919 played its first full schedule since 1916. A football schedule was carried out this autumn after an interruption of three years. It has been gratifying to note the rapidity with which the normal student life has been resumed.

Absence in France.

It was my privilege to serve as one of three members of the Overseas Educational Commission, which directed the educational program developed among the soldiers in the American Expeditionary Forces. I sailed for France on Nov. 30, 1918, and on arrival proceeded to organize the vocational work, particularly that in agriculture. While the commission went over under the auspices of the Y. M. C. A., the army subsequently assumed full responsibility for its work, and all those serving in connection with the project became civilian employees of the army, and were designated as the Educational Corps; the commission became the Educational Corps Commission.

The early demobilization of the American army in France resulted in our being obliged to curtail our program and to bring our educational work to an abrupt conclusion. Early in June I was able to practically close the work of which I had charge, and reached home June 23, in time for commencement.

Other members of our staff who rendered efficient service in connection with the educational work in France were Professors A. E. Cance, J. C. McNutt and R. J. Sprague. A goodly number of our alumni served as teachers and educational advisers at various points in France. The task of directing the work of the college during my absence was performed most successfully by the acting president, Edward M. Lewis. I cannot too strongly express my personal appreciation of the rare skill and complete loyalty with which he carried on the work during my absence, and I know I speak for both trustees and faculty, as well as students, when I say that in the difficult rôle of acting president, Dean Lewis gave abundant satisfaction, and his leadership brought enthusiastic support.

Resignations.

In the spring of 1919 Prof. W. D. Hurd, who had for nearly ten years been director of our Extension Service, resigned to accept an attractive position with the National Fertilizer Association. Professor Hurd came to the institution when Extension Service was a new enterprise, not only in this State but throughout the country. He did truly pioneer work in developing our State system of Extension Service, and evolved an organization and system of administration which was one of the most comprehensive and effective to be found in the country. Indeed, as the extension work became nationalized through Federal legislation and executive oversight, the general plan of administrative organization which Director Hurd developed here was regarded as in many ways a model. During the last five years of Director Hurd's administration the State had appropriated annually \$50,000 for extension work, and this amount was in 1919 increased to \$78,000. The Smith Lever and other Federal funds brought the total amount available for extension work up to nearly \$100,000 annually. During the war the United States Department of Agriculture made fur-

ther emergency grants of money to the administration of our Extension Service for the support of projects in home economics, agricultural production and in boys' and girls' club work. For something over half a year during the war Professor Hurd was assistant to the Secretary of Agriculture of the United States. He was an active member, and at one time chairman, of the committee on extension service of the Association of American Agricultural Colleges and Experiment Stations. Professor Hurd was skillful in selecting members of his staff, and their loyalty to him was most marked. His service was a notable piece of constructive educational work for Massachusetts, pursued with great energy and keen foresight.

Prof. A. G. Hecht, head of our Department of Floriculture, who had for some months served in the army, resigned, shortly after his return, to take up business activities in St. Louis. Professor Hecht was an able administrator and teacher, and a man well trained in his subject. It was with regret that we accepted his resignation, because we had been confident that under his guidance our Department of Floriculture would develop until it should take its rightful place of leadership, not only among the colleges of the country, but also among the commercial florists of the State.

New Appointments.

Mr. John D. Willard has been elected director of Extension Service to succeed Professor Hurd, and it is expected that he will assume the responsibilities of this office Jan. 1, 1920. Mr. Willard in 1916 was eminently successful as secretary of the Franklin County Farm Bureau. Early in 1917 he became executive secretary of the food committee of the Massachusetts Public Safety Committee, and later served as assistant to Henry D. Endicott, Food Administrator of Massachusetts. Early in 1919 Mr. Willard came on to the college staff in charge of the extension work in marketing. In July Governor Coolidge appointed him to the Commission on the Necessaries of Life, and for the past four months Mr. Willard has been devoting practically all of his time to this work.

Mr. Clark L. Thayer has been chosen to succeed Prof. A. G. Hecht as head of the Department of Floriculture. Mr. Thayer

is a graduate of this college in the class of 1913, and since graduation has taught in the department of floriculture at Cornell University under the direction of Prof. E. A. White, formerly of this institution. Mr. Thayer enters upon his task here with an excellent academic training and a rich practical experience.

War Record of the College.

I cannot too frequently call attention to the splendid war record of the college, not only as reflected by the number of students, alumni and faculty participating in the war, but also as indicated by the service which the institution rendered by its large force of scientific experts who contributed their time throughout the war period. The following table has been compiled from the latest records of those serving in the army and navy:—

War Record of the College.

	Total in Service (Army, Navy, Marine Corps).	Commis- sioned Officers.	Overseas.	Deaths.	Additional in State Guard.	Additional in Y.M.C.A., Red Cross, etc.
Faculty, ...	20	14	8	1	-	2
Class:—						
1873, ...	-	-	-	-	1	-
1876, ...	-	-	-	-	1	-
1878, ...	1	1	-	-	1	-
1882, ...	2	2	-	-	2	-
1885, ...	2	2	1	-	-	-
1886, ...	-	-	-	-	2	-
1890, ...	1	1	-	-	-	1
1891, ...	-	-	-	-	2	1
1892, ...	-	-	-	-	1	-
1893, ...	-	-	-	-	1	-
1894, ...	1	1	-	-	-	-
1895, ...	2	2	2	-	1	1
1896, ...	-	-	-	-	3	-
1897, ...	2	2	-	-	1	-
1898, ...	-	-	-	-	1	-
1899, ...	1	1	1	-	2	-
1900, ...	1	1	-	-	-	1

War Record of the College — Concluded.

	Total in Service (Army, Navy, Marine Corps).	Commis- sioned Officers.	Overseas.	Deaths.	Addi- tional in State Guard.	Addi- tional in Y.M.C.A., Red Cross, etc.
1901, ...	1	—	—	—	1	—
1902, ...	1	—	—	—	—	—
1903, ...	3	3	1	—	1	—
1904, ...	1	1	—	—	1	—
1905, ...	—	—	—	—	1	1
1906, ...	4	4	3	—	2	1
1907, ...	6	4	3	—	—	1
1908, ...	9	6	4	1	1	—
1909, ...	7	2	2	—	2	—
1910, ...	13	5	6	2	3	—
1911, ...	19	7	10	2	—	—
1912, ...	36	18	17	1	4	3
1913, ...	48	24	26	6	—	1
1914, ...	73	33	29	2	—	—
1915, ...	78	31	37	1	—	1
1916, ...	107	47	50	2	—	1
1917, ...	129	55	56	7	1	—
1918, ...	137	66	71	7	—	2
1919, ...	158	52	57	6	—	1
1920, ...	130	26	25	3	3	—
1921, ...	92	11	4	2	—	—
1922, ...	108	—	1	—	—	—
Graduate students, . .	39	4	11	2	—	—
Unclassified, ...	62	12	16	5	1	1
Total, ...	1,318	437	441	50	33	19

The secretary of the college is still working on this record in order that it may be as complete as possible, and it is proposed to publish in the near future a rather comprehensive report on the full participation of the college in the war.

Alumni Memorial Building.

In the spring of 1919, Acting President Lewis invited a group of some twenty-five representative alumni residing in the vicinity of Boston to meet him there and discuss various

problems confronting the institution; among other things which were considered at that time was the question of erecting a suitable memorial to commemorate the splendid war record of our alumni and students, but more especially to serve as a memorial to the fifty M. A. C. boys who gave their lives in the great war. As a result of this conference the Alumni Association held a banquet in Boston on May 23. It has been said by many to have been the most significant alumni meeting in the history of the college; 288 were present. Tentative plans for erecting a student memorial building which would cost \$150,000 were presented at that time; the alumni unanimously endorsed the project, and that evening subscribed approximately \$20,000 toward it. Subsequently the campaign for raising the balance of the fund was organized under the direction of an alumni committee, with Mr. Almon W. Spaulding of the class of 1917 as manager. The campaign was launched the 1st of October, and as a result \$143,000 has to date been subscribed. The response of the students to the appeal for support was remarkable; \$26,000, subscribed by them during the campus campaign, was pledged practically in twenty-four hours. The memorial building will be located in the area south of the stone chapel, and will serve as headquarters for various student activities and will be the center of the social life of the college.

I cannot commend too highly the spirit which inspired this project, nor the splendid success which has thus far been attained in the campaign for funds. It is the first time that our alumni have been asked to make any large contribution for the benefit of the institution. The purpose of the building is, in my judgment, ideal, and the whole effort will certainly result in bringing the body of loyal alumni into still closer touch with the institution. It is indeed a courageous undertaking for a small college without wealthy alumni to assume so large a responsibility. Its immediate success and the enthusiasm and energy with which it was carried out are simply indicative of what one may well, without any attempt at rhetoric, characterize as the traditional "Aggie spirit."

Memorial Service.

On June 11 there was held in Stockbridge Hall a memorial service in memory of our men who gave their lives in the war. The relatives and friends of the men were invited, and 17 out of the 50 families were represented. Luncheon was served at 1 o'clock, and at 3 P.M. the following program was carried out: —

Organ prelude.

Invocation.

Rev. JOHN A. HAWLEY

Organ solo, prelude in C Minor, ... *Chopin*
Mrs. EDNA K. WATTS

Remarks in behalf of the trustees.

Mr. CHARLES A. GLEASON

Vocal solo, "Lest We Forget," *DeKoven*
Mr. HARLAN N. WORTHLEY, 1918

Remarks in behalf of the alumni.

Dr. JOSEPH B. LINDSEY

Organ solo, Prelude and Fugue in G, ... *Bach*
Mrs. EDNA K. WATTS

Remarks in behalf of the faculty.

Dean EDWARD M. LEWIS

Vocal solo, "The Americans Come," *Fay Foster*
Mr. HARLAN N. WORTHLEY, 1918

Benediction.

Rev. JOHN HAWLEY

Organ postlude.

Practically all the students were present, as well as a large number of faculty and towns people.

Commencement.

The annual commencement was held Tuesday, June 24. Albert R. Mann, Dean of the College of Agriculture of Cornell University, delivered the commencement address, his subject being, "The Place of the Trained Man in Agriculture." Degrees were awarded to 61 men and 10 women. The degree of bachelor of science honoraria causa was also conferred upon 25

former members of the college who died in military service and who did not remain in college long enough to complete their work.

The degree of master of science was conferred upon one candidate.

Legislative Appropriations.

The Legislature in 1919 was requested to appropriate \$150,000 for the construction and equipment of a women's building; \$45,000 for miscellaneous improvements and equipment; and \$15,000 for the market-garden field station. The appropriations granted were as follows: women's building and equipment, \$127,400; miscellaneous improvements and new equipment, \$20,000; market-garden field station, \$15,000; for a special study of the grounds, \$2,000, making a total of \$164,400.

Improvements and New Construction.

The improvements completed during the present fiscal year include the turbine building provided in 1918. This is a brick building in which is stored all of the electrical equipment of the power plant. The building was completed late in the spring. Numerous improvements have been made in the building and grounds to make them more suitable for the needs of the institution. The construction of the women's building was begun early in November, and it is hoped that sufficient progress may be made before winter closes in to permit the contractors to continue work during the winter with little interruption.

Consolidation Law.

Following the mandate of the voters of the Commonwealth as expressed by their approval of an amendment to the Constitution referred to them by the Constitutional Convention, the Legislature of 1919 was obligated to pass a law consolidating all the State boards, departments and commissions into not more than twenty groups. The Massachusetts Agricultural College was logically placed in the group of other educational institutions, all of which are included in the Department of Education. (General Acts of 1919, chapter 350, Part III, Division 9.)

The College as a State Institution.

The college has now for a full fiscal year been operated as a "State institution." We have been obliged to make numerous adjustments in our methods of accounting, payment of bills and other details of administration. The college has made every effort to comply in all respects with the laws and new administrative rules governing the work of the college, and has found the various State departments and officials responsible for the administration of these laws most patient and indeed generous in helping us to make the various adjustments. It is quite possible that some rather important and even serious problems of institutional efficiency may arise out of the new requirements. A State budget system is unquestionably necessary and desirable. It is highly appropriate that the Commissioner of Education should head the educational forces of the State. The only question is, how can the greatest efficiency of the college itself be sustained, with such initiative and final authority as are necessary to that efficiency still residing in the trustees and faculty, and at the same time conform loyally, thoroughly and fully to the new centralizing plan that has undoubtedly come to stay. I feel very sure that these matters can be worked out. Certainly, we must show the same spirit of courtesy and good will that has been shown us by the officials from the State House.

Standardization of Salaries.

Pursuant to the State law, the Supervisor of Administration has, in consultation with the president of the college, been studying the problem of standardizing the salaries, duties, qualifications and titles of the officers of the institution. The college has welcomed the initiative of the Supervisor in this effort, and I hope that out of it may come many advantages to the institution, such as the specification of titles, the more definite establishment of grades with respect to salary, a substantial increase in actual and prospective salaries, an adjustment in discrepancies of titles and salaries, and, above all, a greater certainty to the members of our staff of reasonable and adequate salary advances, combined with a fuller knowledge of what a staff member may reasonably expect ultimately to receive.

The Departments of Undergraduate Instruction.

As has already been indicated, the work of the past year has been largely that of readjustment. The departments, especially those in agriculture and horticulture and the sciences, have all been confronted with numerous problems of relationship between the two-year course and the four-year course. Thus far the adjustments at this point have been happily made. A number of instructors who have served in the war have returned during the year to resume their work, although a number of other instructors have resigned. Heads of divisions are unanimous in expressing the opinion that something must be done in the way of larger salaries if we are to maintain our present staff or our present quality of instructors. Quite a few of our best men have left during the year to accept more attractive positions in educational work or in commercial activities.

The effectiveness of the work in the Department of Agricultural Education has been greatly increased by the appointment of an additional professor who, in co-operation with the Department of Education, is giving special attention to the training of teachers for agricultural work.

We still feel very keenly the handicap of inadequate facilities in certain directions. The need of the library is more pressing than ever, chiefly in view of the fact that we have more students on the campus than ever before. The chemistry laboratory is becoming more and more inadequate, and certainly the instruction given there is performed under conditions which lessen its effectiveness and economy in operation.

Women's Work.

Miss Edna L. Skinner was appointed professor of home economics at the beginning of the second term of the current calendar year. She is also serving for the present as adviser of women students. With no adequate facilities for teaching home economics, she has had to overcome a good many handicaps; the work, however, is being enthusiastically received by the women students who desire to supplement their training in agriculture with a limited number of courses in home economics and allied subjects. One of our problems is to develop

the general field of homemaking, especially in respect to preparation for the rural home. We need ampler facilities than we can possibly provide at present, with a reasonable amount of equipment and some additions to the teaching force. During the year Miss Margaret Hamlin has been designated definitely as vocational counselor for women, with particular reference to helping women who desire to enter agriculture. She has succeeded in placing quite a number of our graduates in permanent positions, and has a record of applications much greater than we have thus far been able to fill. There is no doubt whatever but women are coming to the college in increasing numbers, both for agriculture and for homemaking, and it is only fair to them and to the people of the State that we should as rapidly as possible make fully adequate provision for housing and for teaching.

One of the problems confronting the management of women's work has been that of making adjustments for an increasing number of women students in a college where all the policies, equipment and methods have been intended to meet the requirements of men students. For example, there are no traditions of social life. Much improvement has been made, particularly in the creation of the *esprit de corps*; social regulations have been revised, and the Student Government Association organized. The interest of women in all phases of agriculture has been markedly increased during the past year. An endeavor has been made to enforce the idea that the farm and the farm home are a unit. Women studying agriculture, therefore, are offered courses in homemaking. A clothing laboratory and a food laboratory have been equipped for this purpose and are now in use. The completion of the dormitory for women will not only afford adequate accommodations for the rooming of a hundred students, but it will meet some of the difficulties that have been mentioned.

The Infirmary.

A special need growing out of the increase of women students is in the procurement of satisfactory infirmary facilities. Inasmuch as these facilities are already rather crowded for men students, it will probably be necessary within a few years to

construct a fairly large infirmary building, and, indeed, it may be wise to provide two buildings, one for men and one for women. All this confirms the judgment of Dr. Marshall, the supervisor of the infirmary, that we must have first-class hospital facilities and a hospital force to meet exigencies as well as the ordinary needs.

Market-Garden Field Station.

During the past two years two greenhouses, a boiler house and a farmer's cottage have been constructed. On account of the increased cost of building some changes had to be made in the plans, but the appropriations were not exceeded. The station is now on a permanent and substantial basis and fully meeting the work expected of it.

The Library.

The attendance records for the library show a marked increase in library use. Careful records kept during October, for example, show that 3,277 visited the library in October a year ago, and 6,010 in October of this year. The branch library in Stockbridge Hall had 430 visitors the same month a year ago, and 1,132 this year. The book accessions for the year have been creditable. There are now 62,000 volumes on hand, about double the number ten years ago. It is hardly necessary to repeat the plea that has been made over and over again for the last sixteen or eighteen years as to the need of a new building to house this equipment. The library extension work continues to grow. Collections of the latest books on agriculture and home economics are loaned to the libraries of the Commonwealth, and package libraries on special subjects in these fields are sent out. All this material is loaned for a period of eight weeks, subject to a renewal when possible.

Department of Physical Education.

During the year Professor Hicks, Professor Gore and Mr. Derby all returned from war service duties to the regular work here. Physical drill is now a requirement in the training of the Reserve Officers Training Corps, so that it is now carried

on under the joint supervision of the professor of military science and tactics and the physical director. Active interest has been maintained in interclass athletics, and, as already indicated in this report, intercollegiate athletics have been resumed. It seems to be a fact that service men returning to college have an unusual interest in athletic work. The department has also had to meet the problem of providing exercises for nearly two hundred men in the two-year course. During the past fall the attendance of the men in the work of this department is at least 50 per cent greater than at any previous time in the history of the institution. The perennial need of the department is a new gymnasium. The present drill hall cannot be used for gymnastics, and repeated attempts to do this have finally been abandoned. In other words, the department has to confine its work almost wholly to athletics. Athletic field facilities are somewhat less pressing, but still should be provided, particularly so long as we have no gymnasium.

Department of Military Science and Tactics.

The work with the Reserve Officers Training Corps, under the supervision of the War Department, has been resumed. We believe that this plan, carrying as it does a progressive scheme of instruction, will develop great interest among the student body as well as harmonize with the general governmental policy. The head of the department finds the drill hall completely inadequate, and states that the failure of the State to provide armory facilities is so serious a handicap that it defeats to a very large extent the real purpose of the military drill.

During the year Col. R. H. Wilson, who had been in charge of the department for two years, retired from service here and his place was taken by Col. R. H. Walker. Colonel Wilson was especially effective with the Student Army Training Corps unit. The results obtained with the unit during the autumn term were really remarkable. The showing of the men as they paraded on Armistice Day was a revelation. Colonel Walker comes to us out of the abundant experience in the army, and full of enthusiasm for the possibilities of the Reserve Officers Training Corps.

LEGISLATIVE BUDGET, 1920.

The legislative budget, as adopted by the Board of Trustees last October, calls for considerable increases, both in funds for current expenses and in special appropriations for permanent improvement. There are four main groups of needs which the Legislature is asked to meet through increases in the appropriations for current expenses, as follows:—

1. Increase of salaries for the members of the staff. This is, by all odds, the most important single need of the institution. So much has been said publicly concerning the humiliating position in which the teachers, both in public schools and in colleges, find themselves in this era of high prices that I do not care to repeat the argument for illustration here. I can only enforce with all the power at my command the pleas that have been made repeatedly by presidents of many of our leading universities and colleges, both endowed and state supported, on behalf of higher salaries for members of the staff. The matter has become more than serious; it has become critical. Men are leaving us for other lines of work. The morale is being broken down, and discouragement and disheartenment will soon result unless the remedy is immediately applied. The increases we ask are modest, undoubtedly less than are deserved, but we hope that these increases, taken in connection with adjustments of salary grades which members of our staff may reasonably expect to achieve within a few years, will at least do reasonable justice to the situation.

2. A number of new positions are asked for on the teaching force, in the Experiment Station and in the Extension Service. We have not asked for the establishment of any new position that we did not think was absolutely necessary in order to make it possible for the institution to render the service that is being demanded of it by the people of the State. We must remember that the college, in all lines of its work, is an investment. If the college does its work well, for every dollar that the State puts in to the support of the college many dollars are returned to the productivity and welfare of the Commonwealth.

3. In the Extension Service an unusually large increase is required, not only because of new demands, but because the

withdrawal of United States funds, both emergency war funds and other funds which had been available, make it necessary for the State to make good the loss, or else we shall have to entirely drop many important lines of extension activity which have, without any doubt whatever, found a place in the agricultural educational system of the State. There is also included in the Extension Service budget an item for the appropriation of State funds to aid directly the county farm bureaus. It is a matter of very great gratification to us all that the farm bureaus are asking for this through the college in order that not only they may have the larger support to which they feel they are entitled, but in order that there may be the closest possible co-operation between them and the Extension Service of the college.

4. The nominal increase in our request for current expenses is much larger than the actual increase in former years, because under State law we are obliged to return to the State treasury all income, no matter how earned. For example, all of the receipts from the farm, the dairy, the poultry plant, the horticultural department go directly to the State treasury. The so-called producing departments, therefore, are charged with all the expenses of growing crops, producing milk, etc., but without any opportunity to receive credit in money for the sale resulting from their productivity. This is unfortunate in many ways. Under a system by which departments do get credit for what they sell, it often happens that the larger the gross expenditures the less the net cost to the college because the larger expenditure has resulted in increased production. On the other hand, under the present plan, every expenditure for producing or harvesting simply adds to the cost of the department. It is universally agreed upon the campus that this system does not work well from the college point of view. Whether it can be changed is another question.

Requests for Special Appropriations for Permanent Improvements.

It has been difficult for the trustees to reach a conclusion as to the wisest and fairest policy to follow with respect to special appropriations from the incoming Legislature. The building

program of the college, already far behind the needs of the institution, was practically laid aside during the war. It is recognized that other State institutions pursued a similar policy, and that the total requests from these institutions will be very large indeed. It is also recognized that we are in an era of high costs for buildings. Our best advice is, however, that we can hardly look for any sharp decrease in building costs for some time to come. The attendance at the college is larger than ever before, and need for room and equipment will increase rather than diminish. It has seemed, therefore, as if the trustees were best meeting their duty by presenting a budget which represented the present needs of the institution, leaving it to the responsible State authorities to indicate what the State can afford to spend upon the institution another year.

The specific items in the special legislative budget are as follows:—

Library Building and Equipment.

In the report of the trustees for the fiscal year 1915 the library building was requested and the needs for it outlined. Attention is called to the fact that late President Goodell, who himself acted as college librarian for many years, as far back as 1902 emphasized the need for a new library building. This need, of course, has strengthened with the years. The report of the Commission on Investigation of Agricultural Education, made in January, 1918, said that "An adequate library building is at present one of the greatest material needs of the college."

The original estimate for this building has, of course, to be increased. It is believed that to carry out the plans adopted by the trustees it will be necessary to call for an appropriation of \$425,000. Probably about one-third of this amount will be required during the fiscal year in which the building is begun.

Chemistry Laboratory and Equipment.

While this is the first time that this structure has been asked for, it has been under discussion for many years. The Commission on Investigation of Agricultural Education said that "An adequate chemistry laboratory is equally needed. The present chemistry building is one of the oldest, most dilapi-

dated and most unsuitable buildings on the campus." Chemistry is a subject required of every student because it is fundamental in all agricultural work. For the same reason the research work in chemistry demands more space than does any other single branch of investigation. It is estimated that it will require an appropriation of \$600,000 to build and equip a building that will be at all adequate to meet the situation. As in the case of the library, however, not more than one-third of this amount will be needed during the fiscal year.

Miscellaneous Improvements and Equipment.

The time has come when the college should be liberally treated with reference to the making of a large number of miscellaneous improvements and the purchase of many items of equipment for the different departments. For many years past our requests for these things have been seriously cut by the Legislature. The result is that some departments are almost scandalously short of equipment. This item is in turn composed of a large number of separate items which are indicated in the list submitted to the Supervisor of Administration, together with definite projects covering each detail. The aggregate in figures is \$120,000.

A Dwelling for Farm Help.

There can be no question but far more efficient farm help can be kept at the college if provision is made for residence near the college buildings. This is especially desirable, as the barn and piggery are south of the college farm. It is believed that this house can be built at a very reasonable figure by using timber belonging to the college. The estimate is \$5,000.

The Extension of the Rural Engineering Shops.

These shops, erected nearly four years ago, are totally inadequate to accommodate the large number of students taking the work. As was expected when the department was organized, it has developed into one of the most useful and popular of the practical departments, and there is clearly no limit to the service that it can render to the students and the farmers of the State. Farm machinery is becoming more and more an im-

portant factor in agriculture. Simply to meet the existing demand requires that the present space be doubled; this will cost \$25,000.

Improvements at Power and Heating Plant.

The request for an appropriation aggregating \$80,000 for the power plant is made necessary when we consider the needs of the institution from an economic point of view. Two of the old boilers should have their foundations replaced the coming year, the cost of which is approximately \$5,000. They are seventeen years old, and when they are twenty years old it will be necessary to replace them, as their pressure will undoubtedly be cut down. It seems, therefore, that the economic thing to do is to put in two boilers next year. With the new building being erected, we should have a spare boiler so that it will not be necessary to run the entire battery during the peak load without having any boiler for emergency service. We recommend that two Heine water tube boilers, 400 horse power, be installed with stokers. At this time the Dillon boiler, which was purchased in 1915, should be connected with a stoker also. The feed water heater is in very poor condition. It is of too small a capacity, and was secondhand when purchased. We recommend the purchase of a heater.

With the increased lighting requirement there continues to be wasted every year a considerable amount of exhaust steam. We recommend that a tunnel be constructed from the power plant north to Flint Laboratory and Stockbridge Hall, through which all steam mains may be carried. This would allow us to install a heating main carrying exhaust steam to these buildings, which would take care of the loss of steam.

Stable for Cavalry Unit.

The United States War Department has notified the college that it will send to this institution and maintain a unit of at least thirty horses, the maintenance to include feed, care, veterinary service and blacksmithing. This will permit cavalry drill to be added to infantry drill as a part of the military education carried on at all of the institutions which receive Federal aid as does ours. The only requirement placed upon the college

is to build a stable that will accommodate the horses. It is estimated that this will cost \$15,000; in this case it is believed that substantial savings can be made by the use of lumber cut from the college forests.

The Celebration of the Fiftieth Anniversary of the College.

It will be recalled that rather elaborate preparations had been made for the celebration of the fiftieth anniversary of the opening of the college to students, through a program which was to have taken place in October, 1917. Because of the entrance of the country into the war it was thought that it would be impossible to carry out the program with satisfaction, and it was therefore entirely canceled. It is now proposed to resume the project for a celebration, and you will have laid before you plans originating with a committee of the faculty, looking toward a celebration going over a period of about a year, beginning with the laying of the cornerstone of the new Memorial Hall next spring and ending in June, 1921, at Commencement time, with a dedication of the Memorial Hall, a presentation of the pageant which had been prepared for 1917, a celebration of the fiftieth anniversary of the graduation of the first class of the college in 1871, and other appropriate exercises. Between these dates it is proposed to hold a series of conferences, the college either acting as host or co-operating with other organizations and places, these conferences to bear upon some phase of the development of agriculture and country life. The Association of Land Grant Colleges has again voted to meet in Springfield some time next autumn, and the delegates will arrange to spend a day at the college. I will not go into further detail at the present time. I do want to call attention to the fact that to carry out this plan we need a special appropriation from the Legislature.

Some Problems.

In closing, I desire in a very brief way merely to call your attention to some very important questions that must be answered in the near future.

1. *Salaries.*—I have already referred to this matter in another part of this report, but it is of such vital consequence

to the continuing effectiveness of the college that I desire to reiterate the statement that it is the most important single question before us. The increase of salaries is not only a matter of justice to the individuals on the staff, but it is absolutely necessary in order to retain men upon the staff who are effective, and who, to maintain their effectiveness, must be relieved from serious worry in regard to financial matters. College teachers for years have been underpaid.

2. *The building program* of the college is still years behind. I am beginning to wonder if the State of Massachusetts really intends to provide on this campus the buildings and equipment that are absolutely necessary in order to maintain a first-class agricultural college. I ask this question in all seriousness. I am quite aware of the fact that building costs are, at present, extremely high; that several good buildings have been granted by the Legislature during the past few years; and that the buildings we have had are first class and in every way most satisfactory. But there still remains the demand for certain facilities that the college has never been able to get and for the needs of a growing institution. We are ten years behind a normal building program.

3. *Housing of Students.* — A special feature of the building need is that of accommodations for students. At present, the village of Amherst is unable to accommodate the student body in a manner that is satisfactory. Men are living a mile or a mile and a half, some even a greater distance, from the college. The dormitory problem, therefore, is becoming a crucial question. I wish to recommend a very careful consideration of the proposition that will come to you in at least outline form, that we move at once to secure the erection of plain dormitories in the nature of first-class barracks, comfortable and convenient in every way, with the hope that we can at least temporarily relieve the situation in this way, particularly by providing accommodations for the short-course students, and perhaps eventually for freshmen students. But this does not dispose of the problem. The college, at its inception, adopted as a part of its policy the dormitory system for its students. It does not, however, house in its dormitories as many students as it did thirty years ago at a time when the college was generally

looking more and more toward the dormitory system as an integral part of its policy. Our college is obliged to state the fact that it has practically no accommodations whatever for its student body.

4. *Policy and Organization.* — Several years ago, in a report to your Board, I took considerable time to develop what I believed to be the needs of the institution with respect to a study of general policy and organization. For various reasons those studies have materialized only in part, but I feel that the time has fully come when we should put on paper very distinctly a statement of our aims, purposes and methods. I should like to see these made a part of the anniversary celebration.

5. *The Scope of the College.* — In connection with this general need for defining policies, there is a specific feature. I have been conscious, particularly since getting back from Europe, of an increasing call for courses to be given at this institution other than those connected with the vocation of agriculture. The fact that the Massachusetts Agricultural College is the only one of the land grant colleges which confines itself to the agricultural field, while a matter of pride in the past and undoubtedly a matter of advantage at many points, raises the question as to whether, in a great urban State like Massachusetts, the one State educational institution should not serve a wider constituency. I am not at this time expressing any opinion in this matter, but I think it my duty to call your attention to the fact, or at least what seems to me to be a fact, that to an increasing degree the question is being asked of us, and we must, I think, in the near future, give either a negative or an affirmative answer.

In Conclusion.

In conclusion I wish to express to your Board my hearty appreciation for your continued support, for your unwearied devotion in committee work and other trustee obligations, and for your intelligent consideration of the projects that come to you from time to time from the staff of the institution.

KENYON L. BUTTERFIELD,

President.

REPORTS OF OTHER ADMINISTRATIVE OFFICERS.

The Report of the Dean.

Undoubtedly the great problems of the dean's office are those of the scholarship and the life of the students, especially of the freshmen and sophomores. The fact that a large number of freshmen fall below a satisfactory record in scholarship, while very few juniors and seniors fail, is due not merely to the break between the secondary school and the college, but also to the differences in characters of the studies of the first two years and of the last two years. The problem of overcoming the interruption occasioned by the change of school and of methods of instruction has in the last few years been met with increasing sympathy, clearer understanding and a larger degree of success by the method of special advisors working in co-operation with the dean. I believe that tutors may well be employed for a time for freshmen, and that sympathy and study of the needs of all students should continue indefinitely. It is clear to me, also, that actual assistance by tutoring should continue only during one term or, at most, two terms, of the freshman year. The English university seeks to educate only safe practitioners and leaders; the American college seeks to give higher education to as many as can possibly pass. But in neither ideal is there any desire to foist upon the community unsafe men who are to pose as experts or superficial leaders, or, in short, to fill the professional classes with "lame ducks." The man should be strictly on his own feet, on both of them, by the end of the first, or at most, the second, term of his freshman year. After that, sympathy, understanding, encouragement, intimacy, but not tutoring.

In this connection there arises the great problem of student life as it concerns the freshmen and sophomores. This problem is as important in this office as the problem of scholarship. Some method that would bring students and instructors to-

gether socially, but not in mere so-called receptions, in normal, natural fellowship, very commonly should be found. Specifically, freshmen and sophomore instructors should, if necessary, be assisted financially so as to meet the freshmen and sophomores very often in small groups.

The much greater cause, however, of the apparent inability of freshmen and sophomores as compared with juniors and seniors is not in the men but in our college courses. The courses of the freshmen and sophomore years, almost without exception, are more condensed and more difficult than a very large number of those of the two upper years. This difference is due to two fundamental difficulties: —

1. A fundamental difference exists, of course, in the fact that the studies of the first two years are not technical, while those of the last two years are technical. In my opinion the mere liking that a student has for subjects in his major is not an explanation for his better scholarship in those subjects than in the subjects of the first two years. It is evident that many of them are not in his major and are not preferred by him. Nor is his mere acquaintance with the school an explanation. These subjects should really be more difficult because they are technical. Again it seems evident that there is something wrong. As a matter of fact, I wonder whether we can expect real college work if the student is required to carry so many hours a week. Textbook work is possible, but not much beyond. If the work of the latter two years through compulsion of time is forced into laboratory and textbook work only, it will, of course, be easier than the work of the first two years. I believe that in every year of the college course we require too many hours a week.

2. A number of courses in the upper two years are taught, not as education proper, but, in a way, as manual training. It raises, of course, the fundamental question whether this is a college or a training school, and whether the aim of a college is to teach the *science* or the *art*, or *both*. The question is too long for discussion here, but it is an axiom that the college must teach the science, and only illustratively the art. Nearly all subjects taught in this institution merely as arts evidently cannot be made as difficult as courses taught as science in the

freshman and sophomore years. In my opinion they do not belong in the course for a degree; they belong in the short courses. If they must exist in the degree course, which I doubt, they should be greatly condensed. The work should be intensive, if an art can be. There is small question that in some cases the work drawn out into courses covering two years or more might be and ought to be condensed — in a college — into two or three terms. I wonder whether any committee could be appointed that could and would effectively supervise and co-ordinate and evaluate all courses.

If something is not done to remedy this fundamental fallacy, then the passing grade should be higher in the junior and senior years than in the freshman and sophomore years.

During the year an obstacle in the way of assigning courses for students in the irregular conditions in which they found themselves loomed rather large. This obstacle was the large number of prerequisites to various courses. It has led me to question seriously whether a large number of these prerequisites could not be dropped. It seems to me desirable that there should be as much freedom as there possibly can be for students to take individual courses.

Another obstacle in the way of scholarship, particularly for the freshmen, is in the length of the "rushing" season for the fraternities. This year, as well as last, this has been a serious interruption. I suggest that the rushing season should be confined to two weeks, preferably one week before college opens and the first week of college, or the Christmas vacation and the first week after college opens for the winter term.

The war necessarily placed upon the dean's office an endless succession of special cases in regard to credits, requirements for graduation, maximum hours, etc., as well as more difficult questions of advice to our men who were returning from service. During the S. A. T. C. period, when the problems of co-ordination with military training were to be solved, and at the same time the needs of a body of regular students were to be supervised, the office was a very busy place. The acting dean has acted also as counsellor for disabled soldiers sent to this college by the Federal Board.

The unfailing sympathy and counsel of the Acting President and the wise rulings of the committee on scholarship, whose members were most faithful and painstaking, enabled the office to pass through a difficult period.

C. H. PATTERSON,
Acting Dean.

Report of the Director of the Experiment Station.

In spite of after-war conditions, which retained in military service for much of the year several of its staff, the Experiment Station has made positive progress in each of its departments, of which brief mention will be made in detail.

Agriculture. — A series of field experiments, supplemented by pot experiments, was begun with bacterized pest and with barium phosphate. While these experiments were projected partially to satisfy influential parties, they have shown the need for careful research into efficient use of natural materials and natural agencies for crop production in comparison with the customary employment of fertilizers prepared by artificial means. At present, extravagant claims are made for materials used as fertilizers which are based on results obtained under special and even unknown conditions, while strongly condemnatory statements are made with similar unstable foundations.

Agricultural Economics. — The work of this department was almost completely broken up for a time by war service. Nevertheless, a study of Holyoke's food markets was made, and a promising survey of farm ownership in the State has been begun.

Botany. — Positive ground has been gained in the control of lettuce drop and onion smut. These diseases can be effectively prevented by proper use of formaldehyde in the soil.

Chemistry. — The effect of temperature on the rate of chemical change in cranberries in storage has been definitely established. Variations in the character of the fats of milk during the progress of lactation have been determined. A study of the effect of low protein rations on growing calves has been completed. An investigation of jelly-making in co-operation with the Department of Pomology was begun, and a study of the effect of lactic acid in a ration for swine was also started.

Entomology. — The life history of the European corn borer was completed early in the year. The vacancy caused by Mr. Vinal's untimely death has remained unfilled, and the time of the department has been occupied in the necessary investigations of outbreaks of insect pests in various parts of the State.

Horticulture. — The projects of this department are of continuous, long-term character. Their progress has been uninterrupted by any unseasonal conditions. A graduate assistant was added during the year to the staff. The resignation of Dr. Shaw from the research work will cause considerable difficulty in insuring in the future satisfactory progress in some of the work of this department.

Microbiology. — The needs of the medical and sanitary corps of the army made it exceedingly difficult to secure assistants for the prosecution of the investigations in this department. This fall sees the staff nearly complete again, and work being vigorously prosecuted. The De Laval investigations of clarification of milk have been completed and partially published.

Poultry. — The breeding projects are necessarily continuous over a term of years, and their progress has been uninterrupted. As generations increase in numbers, the problem of land and housing becomes serious.

Veterinary Science. — This department also lacked strong members of its staff until the hospital service was demobilized. Shortly after September 1 its work was again organized, and the investigation of poultry diseases is being pushed. Under an act of the last Legislature, the department has renewed the effort to control the spread of bacillary white diarrhoea in poultry by means of blood tests performed on the fowls. Applications are on file for over 12,000 birds to be tested, and additions are made daily.

Changes in staff have not been numerous during the year, and with one exception have occurred in the minor positions. But these changes have occurred because higher salaries could be secured elsewhere, and it has been impossible to fill the vacancies with equally experienced parties. It is obvious that our scale of compensation is too low at present for the needs of our institution.

By the middle of the year lack of money for printing our bulletins became acute, and several manuscripts had to be withheld from the printer until recently, when it became safe to use the contingent reserve for a part of the work, and to carry the completion of other matter into next year. A considerable list of prepared and proposed bulletins has already been submitted to you in connection with the budget for the ensuing year, in which an increase for publications was requested.

The principal and almost the only line of contact of the research departments with the public is through our publications. There is positive need of greater development of this contact by more reports on investigations, either on completed studies or on progress, and also by short, readable statements of methods and results of our investigations which will interest all our constituents when the full report may appeal only to the people engaged in the special fields in which the problems arise. Such brief popular leaflets would be both an advertisement of the station's power for service and a defence against ignorant critics.

As new buildings are projected for the institution, it becomes apparent that some of our station field experiments occupy unusually fine and dominating building sites. Therefore it is clearly evident that it will be a wise forethought to provide as soon as possible some easily accessible fields with suitable soils for field experiments that will be adjacent to our station buildings, if the work of the station in the study of crops and fertilizers is not to be restricted and is to be permitted to grow as it should. Tillson farm is not, as a whole, suited to the station's needs, and is too remote to permit efficient work without the duplication of some of the present buildings and equipment.

The varied interests of our rural population and the highly capitalized lines of intensive crop production in our suburban localities offer numerous opportunities for fruitful investigations, and frequently call for quick solutions of pressing problems. This year four new projects were selected from several propositions and made a part of the estimated budget for next year. They included an investigation of feeding swine with household

garbage; studies in the economical preparation of jellies and other products from surplus fruits; the climatic effects on orchard spraying in eastern Massachusetts; and the beginning of an investigation of rural social conditions; with particular reference to the changes in our farm ownership.

There are so many opportunities for service that it is a serious problem how to complete the projects now under way while undertaking new ones that are asked for by different interests. A specialist in one line cannot, as a rule, be transferred to some other line, and, on the other hand, one cannot be employed satisfactorily for a temporary period. Possibly the solution of the problem may be reached through the use of graduate students, to whom may be assigned a single problem, as their thesis subject.

FRED W. MORSE,
Acting Director.

The Report of the Director of the Extension Service.

Activities of the Extension Service have been directed along lines similar to those in previous years. The emergency program conducted on account of the war has been dropped, and in some respects this has meant a reorganization of effort. Unfortunately it has been necessary to reduce the amount of work along many lines which the State has needed, but which the war only accentuated. This is particularly true of home demonstration and home gardening, entomology and plant pathology. The results of effort along those lines have shown conclusively that for the most part they should be continued in peace times. The same is true of other phases of the work which should have support, but for which no funds are available.

The purpose of the appropriation of public funds, by Congress through its Smith-Lever law and by the State Legislature, for Extension Service in agriculture and home economics was for disseminating agricultural information and giving practical instruction by designated agencies. This necessarily presupposed a close association of those agencies. Progress worthy of note has been made in that direction during the past year. Closer co-operation between the Extension Service of the college and

the farm bureaus has been established, and closer relationships and fairly frequent conference with farm bureau managers have done much to unify, co-ordinate and strengthen all the lines of extension work. In conjunction with farm bureau managers definite outlines of work have been planned for the coming year, and such new phases as they consider urgent have been asked from the Supervisor of Administration and the Legislature. As the result of co-ordinated effort the use of projects has increased, and this in turn has increased the efficiency of the work and enabled the specialists to be of more service to the county agents, and, through them, to the farmers themselves. They have co-operated to assist farmers to raise better roughage for their live stock; to improve their live stock by better breeding; to increase the demand for their milk by advertising; to increase the income from their poultry by early hatching of chicks, better feeding and careful culling; to improve the yield and quality of their potatoes by better selection of seed; to improve their methods of feeding and management of swine; to bring up to date their methods of orchard management and orchard practice; to keep books in order to study more intelligently the question of management and the proper relation of enterprises on the farm; to sell co-operatively those products which are produced individually in such small quantities as to work to the disadvantage of the grower; to develop among people interested in agriculture a farm bureau organization which will choose a definite and profitable program, and to assist in carrying it out in order that agriculture may be more profitable and country life more enjoyable.

In home demonstration work a distinct need has been met by the introduction of nutrition courses for mothers. This is especially true among foreigners, and over 15,000 people of 14 different nationalities have been reached by this work. Closely linked to this was the assistance given to the campaign for advertising the use of milk as food, a movement which has resulted in better nourishment of infants, children and adults, and which has improved the outlook for dairy farming in the State. Equally important is the continuation of the campaign for the preservation of food, which was emphasized as a war measure. This campaign is of vital importance in the solution

of some of the present-day economic problems. In this work over 10,000 housewives were reached. Increased interest has been shown in clothing efficiency, textiles, remodeling of clothes and in millinery. In this work leaders are taught and in turn teach groups of individuals. By this far-reaching method of clothing efficiency over 4,000 garments and 10,000 patterns were made. This service has issued a household account book which enables the family to keep a more businesslike record of the family budget. Extensive instruction has been given in keeping this account, and over 1,000 copies of the book have been distributed, while many others are to be distributed as soon as issued.

The year has seen a return of boys' and girls' club work to a peace basis. The appeal to patriotism due to war conditions gave way to an appeal of the work for the work's sake. The enrollment, not so great as last year, is, however, large enough to show that the work has a strong appeal to hundreds of young people. Although more effort has been concentrated upon having club members complete the work they set out to do, rather than enrolling large initial numbers, there has been a membership from all counties in the State of over 43,000 boys and girls. Emphasis has been placed upon the organization of clubs which hold regular meetings throughout the year, and whose program extends over a period of two, three or four years. This plan retains interest and enthusiasm, — necessary attributes which are not possible with the one-year program of work. The training of demonstration and judging teams has given the young people an opportunity to demonstrate their knowledge of the work they are doing, and their ability to judge the progress of their handiwork at community, county and State fairs. The results of this line of activity of the Extension Service have clearly indicated that it is developing future leaders for the Commonwealth, and that it is advancing the cause of agriculture in the most fertile field, — that of the farm boys and girls.

The principal difficulties which the service has met during the year have been due to the resignation of the director, and to the lack of funds. In the spring Director W. D. Hurd, who has been in the service ten years, left to accept commercial

work which would give him a larger territory for action. In addition to this loss there have been many changes in the staff due to resignations. In most cases the resignations occurred because it was impossible to pay higher salaries. In Massachusetts, extension needs were recognized by the Federal government, and a considerable amount of Federal money was available for extension work in the State during the war. Beginning July 1 there was some reduction in the total amount of Federal funds for extension work available for the entire country, but the change of distribution from the basis of needs to the basis of rural population severely discriminated against some of the States, particularly Massachusetts. As a result twenty-nine co-operative home demonstration agents were dropped, and also specialists in entomology, plant pathology and junior poultry clubs. Some losses have also resulted from our inability to increase the salary of men paid entirely from State funds. Apparently other State colleges are able to pay from \$500 to \$1,500 more for the same grade of work, — a condition which results in numerous resignations from our staff.

The spirit of the whole college — Experiment Station, resident teaching and extension — has been most satisfactory, and with the closer understanding existing between the farm bureaus extension work appears to be making healthy progress.

RALPH W. REDMAN,
Acting Director.

Report of the Director of the Graduate School.

Our graduate school suffered severely from the effects of the war. Accordingly, what we have to report upon are the mere fragments left behind.

The most important problems which confront the graduate school may be discussed briefly in the following manner: —

I. It becomes more and more evident that most of the students seeking entrance to the graduate school are very deficient in fundamental training and knowledge essential to the pursuit of graduate specialization and intensive study. Too often it is necessary to place these students back in undergraduate courses even as far as the freshman year. This, of

course, interferes very seriously with graduate work, and is discouraging to the student involved.

There is a common desire on the part of leaders in agriculture to place agriculture on the same plane as other leading professions. Wonder is often expressed why this cannot be done. Professions are not manufactured or made, they result from growth and development. Medicine, for instance, has moved ahead very rapidly and satisfactorily to a high plane of development, largely because university schools of medicine have forged ahead in the face of their clientele or practitioners, and because they have appreciated the bearing of the deepest, most intense, and most comprehensive study of all problems related. Consequently, they have fostered such study. This was done even when practitioners were antagonistic and could not see the force of such study or research, and looked upon the work as impracticable.

In agriculture the trained leaders of agriculture, who are most sympathetic and concerned, find the drags or influence which weigh them down so heavy as to nullify to a large extent the efforts made to rise out of stagnation. Progress is very, very slow. There is such a strong pull from constituents that instead of rising to new levels, a tendency exists to drop into the empiricism of agriculture as now largely practiced and recognized.

It is only possible for agriculture to grow through men who are as well trained as the university leaders in medicine, whose attitude is that of seeking new developments, whose training is commensurate with their difficult undertakings and the advancement of wisdom, and whose contributions, although perhaps not immediately interpretable in practice, will eventually enrich agriculture. Such spirit is not one of humiliating descendancy or stagnation, but is leadership which lifts. Agriculture needs the best and severest training possible to produce real leaders for the purpose of forging ahead. Basic or fundamental training and learning means grounding in subjects which will enable the student to grow, to rise without restriction or curbing, as against subjects which consist only of present and perhaps temporary methods or procedures. These are valuable

and necessary in their place, but are of very limited range outside of their own boundaries as subjects.

Graduate students should possess the most rigid training in fundamental subjects as undergraduates and as preparatory for specialized graduate study. This the agricultural college fails to furnish, although it is the only center on account of the environment where it can be done sympathetically.

II. As would be naturally anticipated under the stress of demands upon the instructor in an agricultural college, little energy remains to direct graduate study after other duties, which seemingly are more pressing, are accomplished. This doubtless leads to a condition of graduate study in some departments which is not satisfactory. The writer sometimes feels, too, that there is a want of appreciation and knowledge of graduate work in some departments which works mischief or depreciates standards and quality of work. If in a department a differentiation between "short-course" instruction, "undergraduate" instruction and "graduate" instruction cannot be made, then graduate instruction should not be undertaken. If, however, it is a lack of time or energy only, then much can be accomplished by organization within the scope of our "apprenticeship" system. Graduate study is and should be distinctive from all prior methods and study, for it is not only extended knowledge, but is peculiarly another attitude and atmosphere.

III. Graduate assistantships should be greatly encouraged. They have proven highly meritorious. The ambition to complete graduate study for an advanced degree makes these assistantships unusually valuable, and especially is this so when the graduate assistant majors in the department in which he serves. The graduate assistant is so intimately bound up with the department's activities that the experiences thus gained redound greatly to his education. When properly organized, they return to the department not only what is expected in actual service, but in addition an amount which is expended in energy and expense in their special instruction.

Nearly all the leading universities have fellowships or scholarships which enable graduate students to live fairly well. With

this institution their remuneration for half time is not at present sufficient to cover living expenses.

The time should approach in the near future when it will be possible to exercise to a much greater degree than in the past a discriminating power of selection among candidates for vacancies.

IV. An intangible subject, yet real, an institutional "atmosphere" is of great import in graduate study. A large part of the institutional life flows out into the field as "extension service," leaving an anæmic condition behind. There is scarcely enough "real red blood" left to revitalize the actual work of the organism, the college. This "letting of blood" for the "life" of the field is commendable and generous, but the time arrives when the organism which furnishes the "blood" succumbs, and in most cases the "patient" in the field will succumb, too. In order to maintain a constant flow fieldward, the vitality in the institution should be superabundant or large enough to maintain the "standard of vitality" within, and the "patients" in the field must assume the rôle of strong men who will join in helpfulness as a part of the organic whole in advancing agriculture.

With the flow out there has developed within the institution a spirit which lacks creative purpose and which has been substituted by a missionary purpose. The latter is a most commendable ideal, but when it dominates, agriculture remains unprogressive — it distributes what is and seeks no more: but *when properly combined* with the former, new developments are inevitable.

So little emphasis and energy have been given to the constructive processes within the institution that its functioning powers are lowering. So weak are they becoming that the spirit which is an expression of vigorous life fails in large degree. The intangible "atmosphere" which makes the institution a center of agricultural learning, research and instruction is somewhat deoxygenated.

The treatment of the problems above is designed to point out our institutional drift in the light of graduate study, and not with any desire to criticize.

It is assumed that a large number of the most highly trained

men as specialists will be needed year by year, as has become more clearly evident with the passing years. These men should be trained and educated in an agricultural environment. Anything short of the most rigorous training fundamentally and comprehensively invites a degradative movement in agricultural education and research. Accordingly, undergraduate education for graduate study demands high standards, well-chosen, basic subjects both for intensity and comprehensiveness, exacting requirements and scholarly attainments.

Strictly professional courses, limited courses and special courses have their place in the institution and have definite purposes, but at this time do not call for an interpretation in terms of graduate study.

CHARLES E. MARSHALL,
Director.

The Report of the Director of Short Courses.

PURPOSE.

Short courses in the Massachusetts Agricultural College are organized to provide instruction in agriculture, horticulture and related subjects for men and women who either do not possess college entrance requirements or who, for one reason or another, are unable to take the regular four-year college course. The resources of the college are thus made available to a large number of men and women in the State who otherwise would be unable to profit by them. The experience of the past year indicates a very general demand for such courses.

In my report for 1918 the statement was made that through short-course work the college would serve from 600 to 800 students each year. The total enrollment in all short courses from December, 1918, to November, 1919, was 636. Excluding students counted twice in continuing courses, 590 different persons have been served by the short course during the first fiscal year. The past year has not been a normal one. The Winter School and the first term of the two-year course offered during 1918-19 were seriously affected by the military situation.

If financial support may be had for instruction and maintenance of the courses already existing, and development of

such other courses as may be demanded, I am quite confident that we shall serve, through short-course administration, from 1,000 to 1,500 students a year. These students will not all be here at one time, but will come in groups for special lines of work at different periods of the year.

It is not the purpose of the short courses to enter the field of secondary agricultural education, but to provide practical courses for those men and women who feel that they are too old to enter the secondary school, and for men and women of more mature years and practical experience who wish to take advantage of the opportunities offered by the college. That there is such a mature group in the State is shown by the following age classification of the 238 students now enrolled in short courses: —

AGE.	Number of Students.	Per cent.
17-18, ...	10	4
18-19, ...	18	7
19-20, ...	31	13
20-21, ...	25	11
21-22, ...	29	12
22-23, ...	18	7
23-24, ...	11	5
24-25, ...	19	8
Over 25, ...	77	33
	238	100

Classification of Short Courses.

The Two-Year Course in Practical Agriculture.

The Ten Weeks' Winter School.

The Summer School.

The One-Year Vocational Poultry Course.

The One-Year Course in Rural Engineering.

The Regional School.

The Special Six Weeks' Courses in Agriculture for Returned Soldiers and Sailors.¹

¹ These were emergency courses organized during demobilization, to serve men who wished instruction in agriculture as a preparation for farming.

A committee of the faculty, composed of Professors Foord, Sears, Fernald, Cance, McNutt and Phelan, was appointed by the president to prepare the course of study of the two-year course and to make plans for its permanent organization.

The course as now organized makes available to the student three courses in agronomy, five courses in animal husbandry, five courses in fruit growing, six courses in rural engineering, five courses in dairying, four courses in poultry, four courses in rural home life, three courses in vegetable gardening, three courses in floriculture, two courses in botany, three courses in forestry, four courses in farm business, and one course in each of the following: farm manufacturing, hygiene and sanitation, English, and insect pests.

At the close of six months of study students are required to gain six months of farm experience. The college will assist students in finding positions and in placing them on farms where the experience gained will be of great advantage. Thus an effort will be made to place on a dairy farm the man expecting to take up dairying as his chief line of work, and a student of pomology on a fruit farm.

Two hundred and thirty-eight students have enrolled this fall for the short courses. Of these, 70 are men who have been disabled in military or naval service of the United States and sent here by the Federal Board for Vocational Education. These men vary in academic preparation from college graduates to men who have not completed the common schools. They range in age from eighteen to fifty. The need of these men for education is very great, since the adjustment from war to peace is hard for them to make, particularly in view of the fact that they have suffered disability.

NEEDS OF THE SHORT COURSES.

In considering the needs of the short courses, the most important fact is not that during the first year we enrolled more than 600 men, but the fact that we added to the work of this college the equivalent of fifteen months of instruction for 200 men. The two-year course has created suddenly a small college in itself.

We need more teaching assistance. Several instructors are

now paid out of the short-course funds, but no attempt has been made this year to arrange a short-course staff. Each department is managing the short-course work on exactly the same basis as for any other group of students. This arrangement has been fortunate this year, for it would have been utterly impossible to provide instruction for the men enrolled in the two-year course if the subjects had been taught by members of a small special staff. I am inclined to think, however, that we shall have to create, very rapidly, a special short-course staff. There are some disadvantages to this plan, but there are many advantages. This special staff should have the same relation to the department—that members of the Extension Service staff now have.

Assistance for instruction is our first and greatest need. Short-course classes should be small, twenty-five or thirty men, if we are to achieve the best results. We should begin to add as rapidly as possible, if funds will permit, special short-course instructors. These instructors should be mature men of teaching ability and broad human sympathies.

The second need is for a supervisor of farm practice who could assist in the administration of short-course work. The course of study calls for six months of farm experience. This should be under competent supervision in order that the boys may realize the greatest benefit from the course. The supervisor of farm practice might well take charge of the winter school and teach certain courses during the six months that he would be on the campus.

Summer School. — The summer school for 1919 was under the joint direction of the Massachusetts Agricultural College and the Massachusetts State Board of Education. The college offered instruction in agriculture, horticulture and related subjects. The Board of Education offered courses in elementary education. The arrangement was very satisfactory in every respect; students expressed their appreciation of the plan, and there were many inquiries asking if the plan would be continued another year. The enrollment was 238, the largest in the history of the college. I wish to suggest that for the ensuing year the summer school be lengthened to six weeks; that courses be offered that will carry college credit; and that, if agreeable to the State Board of

Education, the arrangement for a joint management be continued.

More courses in agricultural education and rural social science should be offered in the summer school. All of these courses should carry credit and be so organized that they may be taken up by graduate or undergraduate students.

Winter School. — The winter school for 1919 enrolled 63 students. It has always appealed to a more mature class of students, and the work of the school should be further extended so that young men who can attend only during the winter school might come for two or three years in succession in order to take a series of related courses.

One-Year Vocational Poultry Course. — The one-year vocational poultry course is designed to prepare practical poultrymen. The number of students who enroll in this course is limited by the fact that laboratory provision can be made only for a small group, twelve or fifteen men.

One-Year Course in Rural Engineering. — This course was organized in the fall of 1919, and was designed especially for men sent here by the Federal Board for Vocational Education, who wish instruction in farm machinery.

The Federal Board placed at the college an instructor to give courses in mechanical drawing and physics.

A Regional School. — I wish to urge the advisability of the organization of a regional school of from four to six weeks in connection with some other educational institution located in the eastern part of the State, in or near Boston, by means of which we may offer short courses in practical agriculture to those who cannot come to Amherst for instruction.

The organization of such a school would meet a very definite need. The cost would be small in view of the fact that most of the work would be done by the regular staff of the college.

Special Six Weeks' Course in Practical Agriculture. — Three special six weeks' courses in practical agriculture were offered during the winter of 1919. These courses were designed to offer an opportunity to demobilized men to prepare them for farm work. These courses were organized during the period of demobilization.

JOHN PHELAN,
Director.

TABLES AND STATISTICS.

TABLE I. — *Resignations.*

POSITION.	Name.
Assistant chemist, Experiment Station, ...	Windom A. Allen. ¹
Professor of general and physical chemistry, ...	Ernest Anderson.
Assistant State leader of home economics, ...	Stella A. Belcher.
Extension professor of farm management demonstrations, ...	Wesley H. Bronson.
Clerk, Extension Service, ...	Cassie L. Clark.
Clerk, library, ...	Lois Clark.
Clerk, president's office, ...	Ruth Clow.
Clerk, Extension Service, ...	Elsie H. Cooley.
Instructor in dairying, ...	Harry D. Drain.
Garden supervisor, ...	Henry R. Francis.
Clerk, president's office, ...	Lillian M. Gelinas.
Clerk, poultry husbandry, ...	Nettie A. Gilmore.
Clerk, Division of Agriculture, ...	Mary G. Hanifin.
Instructor in mathematics, ...	Burt A. Hazeltine.
Assistant professor of floriculture, ...	August G. Hecht.
First clerk, Experiment Station, ...	Alice M. Howard.
Director of the Extension Service, ...	William D. Hurd.
Associate professor of dairying, ...	Orville A. Jamison.
Clerk, Extension Service, ...	Ethel L. Kennedy.
Extension assistant professor of pomology, ...	Austin D. Kilham.
Assistant in veterinary science, Experiment Station, ...	John B. Lentz.
Assistant to the director of Extension Service, ...	Daniel J. Lewis.
Chief clerk, Extension Service, ...	Carleton D. Livermore.
Stenographer, treasurer's office, ...	Irene A. Martin.
Assistant chemist, Experiment Station, ...	Esther S. Mixer.
Clerk, treasurer's office, ...	Hazel Parker.
Instructor in farm management	Walter M. Peacock.
Assistant chemist, Experiment Station, ...	Harold B. Pierce.
Associate professor of animal husbandry, ...	Byron E. Pontius.
Associate professor of physics, ...	Harold E. Robbins. ²
Assistant chemist, Experiment Station, ...	Robert S. Scull.
Research pomologist, Experiment Station, ...	Jacob K. Shaw.

¹ Died in service.² Effective Dec. 31, 1919.

TABLE I. *Resignations* — Concluded.

POSITION.	Name.
Extension assistant professor of landscape gardening, ...	Frank A. C. Smith.
Assistant chemist, Experiment Station, ...	John B. Smith.
Extension professor of farm management demonstrations, . .	Benjamin G. Southwick.
Instructor in poultry husbandry, ...	Lloyd L. Stewart.
Extension assistant professor of animal husbandry, ...	William F. Turner.
Chief clerk, Extension Service, ...	Lawrence A. Wheaton.
Curator, Department of Botany, ...	Mae H. Wheeler.

TABLE II. — *New Appointments.*A. *In the Academic Departments.*

POSITION.	Name.	Institution from which graduated, and Degrees.
Instructor in zoölogy, ...	Charles H. Abbott, .	Ph.D., ¹ Brown University, 1918.
Assistant professor of farm management, ...	Max F. Abell, ¹ . . .	B.Sc., Cornell University, 1914.
Assistant, Department of Botany, ...	Alyn S. Ball, ² . . .	- - -
Assistant in physics, ...	Henry J. Burt, ³ . . .	B.Sc., Massachusetts Agricultural College, 1919.
Assistant professor of pomology, ...	Brooks D. Drain, . .	B.Sc., Ohio State University, 1917.
Instructor in pomology, ...	Charles H. Gould, . .	B.Sc., Massachusetts Agricultural College, 1916.
Instructor in physical education, ...	Emory E. Grayson, .	B.Sc., Massachusetts Agricultural College, 1917.
Assistant in physical education, ...	Mrs. C. S. Hicks, ³ . .	Michigan State Normal College, 1909.
Instructor in animal husbandry, ...	Richard L. Holden, .	B.Sc., Massachusetts Agricultural College, 1917.
Associate professor of dairying, ...	Henry F. Judkins, . .	B.Sc., New Hampshire State College, 1911.
Assistant in physical education, ...	Arthur M. McCarthy, .	B.Sc., Massachusetts Agricultural College, 1919.
Instructor in rural engineering, ...	John B. Newlon, . . .	- - -
Instructor in mathematics, ...	Laurence H. Parker, .	A.B., Tufts College, 1902.
Instructor in farm management, ...	Leland Spencer, ⁴ . . .	B.Sc., Cornell University, 1918.
Assistant professor of rural engineering, ...	James L. Strahan, . .	M.Sc., Cornell University, 1913.
Instructor in agronomy, ...	Charles H. Thayer, . .	Short Course, Massachusetts Agricultural College.
Associate professor of floriculture and head of department, ...	Clark L. Thayer, . . .	B.Sc., Massachusetts Agricultural College, 1913.
Instructor in botany, ...	Ray L. Torrey, . . .	B.Sc., Massachusetts Agricultural College, 1912; Ph.D., Harvard University, 1918.
Instructor and foreman, vegetable gardening, ...	Gilbert S. Watts, . . .	B.Sc., Pennsylvania State College, 1918.
Professor of agricultural education, ...	Winthrop S. Welles, .	B.Sc., University of Illinois, 1901.
Instructor in dairying, ...	Fred E. Wheeler, . . .	B.Sc., Cornell University, 1919.

¹ To take effect Jan. 1, 1920.² Transferred from labor account.³ Part time.⁴ Temporary.

TABLE II. *New Appointments* — Continued.*B. In the Experiment Station.*

POSITION.	Name.	Institution from which graduated, and Degrees.
Assistant chemist, ...	Ethel Bradley, ...	B.Sc., Connecticut College, 1919.
Assistant chemist, ...	Arthur M. Clarke, ...	A.B., Amherst College, 1917.
Assistant in veterinary science, ...	Thomas G. Hull, ¹	Ph.D., Yale University.
Curator, Department of Botany, ...	Marguerite G. Ickis, ...	B.Sc., Ohio University, 1918; M.A., Columbia, 1919.
Assistant chemist, ...	Anne C. Messer, ...	A.B., Mount Holyoke College, 1916.

C. In the Extension Service.

Assistant professor of agricultural education.	Lincoln W. Barnes, ¹	B.Sc., Colorado Agricultural College, 1918.
Assistant state leader of home economics.	Stella A. Belcher, ...	- - -
Instructor in horticultural manufactures.	William R. Cole, ...	Massachusetts Agricultural College, 1898-1900.
Assistant professor of animal husbandry.	Roy B. Cooley, ...	B.Sc., Ontario Agricultural College, 1910.
Assistant state leader of home economics.	Laura Gifford, ...	Two years at Teachers College.
Specialist in dairying, ...	Delos L. James, ...	University of Illinois.
Instructor in charge of poultry club work.	Earl H. Nodine, ¹	Connecticut Agricultural College.
Professor of agricultural economics.	John D. Willard, ...	A.B., Amherst College, 1907.
Assistant to the director, ...	John D. Zink, ...	B.Sc., Pennsylvania State College 1916.

D. Miscellaneous.

Farm superintendent, ...	Enos J. Montague, ...	B.Sc., Massachusetts Agricultural College, 1915.
Field agent, ...	Almon W. Spaulding, ...	B.Sc., Massachusetts Agricultural College, 1917.

E. In the Clerical Staff.

POSITION.	Name.
Clerk, president's office, ...	Nellie V. Barkhouse.
Clerk, treasurer's office, ...	Mary Broadfoot.
Secretary, president's office, ...	Evelyn Brewster.
Stenographer, Extension Service, ...	Susan L. Clark.
Clerk, treasurer's office, ...	Grace Colburn.
Stenographer, Extension Service, ...	Elsie H. Cooley.

¹ Temporary.

TABLE II. *New Appointments — Concluded.**E. In the Clerical Staff — Concluded.*

POSITION.	Name.
Clerk, Division of Agriculture, ...	Irene Crutch.
Mailing clerk, Extension Service, ...	Margaret G. Davidson.
Clerk, dean's office, ...	Charlotte E. Erickson.
Library assistant, ...	Lottie M. Fosdick.
Stenographer, Extension Service, ...	Catherine A. Harrington.
Stenographer, Extension Service, ...	Marion E. Hawthorne.
Stenographer, Extension Service, ...	Margaret C. Leduc.
Clerk, Division of Horticulture, ...	Honor A. Lee.
Stenographer, short courses, ...	Marie Mercier.
Clerk, president's office, ...	Rachel C. Packard.
Clerk, short courses, ...	Mildred Pierpont.
Clerk, Extension Service, ...	Jessie M. Prince.
Stenographer, Department of Poultry Husbandry, ...	Laura Sabin.
Clerk, president's office, ...	Marjorie Silcox.
Chief clerk, Extension Service, ...	Lawrence A. Wheaton.

TABLE III. — *Changes in Title and Transfers.**Changes in Title of Officers of the Institution.*

NAME.	Former Title.	Present Title.
Nellie V. Barkhouse, ...	Clerk, president's office, ...	Clerk, home economics office.
Arthur B. Beaumont, ...	Associate professor of agronomy, ...	Professor.
Abram L. Dean, ...	Extension instructor in charge of poultry club work.	Instructor in poultry husbandry.
Charlotte E. Erickson, ...	Clerk, dean's office, ...	Clerk, treasurer's office.
Cora B. Grover, ...	Clerk, Extension Service, ...	Clerk, Experiment Station.
Arao Itano, ...	Assistant professor of microbiology.	Associate professor.
Arthur N. Julian, ...	Instructor in German, ...	Assistant professor.
Anderson A. Mackimmie, ...	Assistant professor of French, ...	Professor.
Frederick A. McLaughlin, ...	Instructor in botany, ...	Assistant professor.
Rebecca L. Mellor, ...	Clerk, Experiment Station, ...	First clerk, Experiment Station.
Charles H. Patterson, ...	Assistant professor of English, ...	Professor.
Victor A. Rice, ...	Extension instructor in charge of pig club work.	Assistant professor of animal husbandry.
Doris Tower, ...	Stenographer, Department Poultry Husbandry.	Clerk, Department of Poultry Husbandry.
John D. Willard, ...	Extension professor of agricultural economics.	Director of the Extension Service.

TABLE IV. — *Leaves of Absence.*

POSITION.	Name.	Cause of Leave.
Foreman of grounds, . . .	Lawrence S. Dickinson, .	Service with Walter Reed Hospital, Washington, D. C.
Professor of poultry husbandry, .	John C. Graham, . . .	Charge of educational work for the blind, Baltimore, Md.
Extension professor of community planning.	Ezra L. Morgan, . . .	Service with the Red Cross.
Extension professor of agricultural economics.	John D. Willard, . . .	Service with Commission on Necessaries of Life.

TABLE V. — *Speakers for the Year.**A. Speakers at Wednesday Assembly for Year ending Nov. 30, 1919.***1918.**

- Dec. 4. — Mr. Herbert A. Parsons, Boston.
 Dec. 18. — Col. Clarence Ousley, Washington, D. C.

1919.

- Jan. 8. — Mr. Ralph S. Rounds, New York City.
 Jan. 15. — Lieutenant V. de Wierzbici, Paris.
 Jan. 22. — Dr. Horace M. Kallen, Boston.
 Jan. 29. — Pres. William A. Neilson, Northampton.
 Feb. 5. — Rev. Charles T. Riggs, Northampton.
 Feb. 12. — Dr. J. N. Mills, Washington, D. C.
 Feb. 19. — Student forum.
 Feb. 26. — Lieut. Harry G. Milsom, Canada.
 Mar. 5. — Rev. Gerald C. Treacy, Boston.
 Mar. 12. — Student forum.
 Apr. 2. — Dr. J. J. Walsh, New York City.
 Apr. 9. — Prof. Albert H. Gilmer, Tufts College.
 Apr. 16. — Dr. Arthur W. Gilbert, Boston.
 Apr. 23. — Prof. W. L. Stoddard, Boston.
 Apr. 30. — Capt. Thomas G. Chamberlain, New York City.
 May 7. — Student forum.
 May 21. — Mr. Bertram Tupper, Newton.
 June 4. — Prof. Charles H. Patterson, M. A. C.
 Oct. 1. — Mr. Howard L. Russell, Worcester.
 Oct. 8. — Dr. W. I. Chamberlin, Hudson, Ohio.
 Oct. 15. — Pres. Kenyon L. Butterfield, M. A. C.
 Oct. 22. — Student forum.
 Oct. 29. — Prof. Robert J. Sprague, M. A. C.
 Nov. 5. — Prof. Fred S. Cooley, Bozeman, Mont.
 Nov. 12. — Hon. Joseph Walker, Boston.
 Nov. 19. — Mr. Alva Agee, Trenton, N. J.

*B. Speakers at Sunday Chapel, for Year ending Nov. 30, 1919.***1918.**

- Dec. 1. — Rev. Henry A. Atkinson, New York City.
 Dec. 8. — Dr. Anson Phelps Stokes, New Haven, Conn.
 Dec. 15. — Rev. John A. Hawley, Amherst.

1919.

- Jan. 5. — Prof. Harry F. Ward, New York City.
 Jan. 12. — Dean Lee McCollester, Tufts College.
 Jan. 19. — Rev. J. C. Sycamore, Holyoke.
 Jan. 26. — Dean Charles R. Brown, New Haven, Conn.
 Feb. 2. — Dr. Albert P. Fitch, Amherst.
 Feb. 9. — Mr. Albert E. Roberts, New York City.
 Feb. 16. — Rev. Charles F. Carter, Hartford, Conn.
 Feb. 23. — Rev. H. G. Ives, Amherst.

B. Speakers at Sunday Chapel, for Year ending Nov. 30, 1919 — Concluded.

1919.

- Mar. 2. — Rev. John Haynes Holmes, New York City.
 Mar. 9. — Mr. Owen R. Lovejoy, New York City.
 Mar. 16. — Bishop Edwin H. Hughes, Melrose.
 Apr. 6. — Rev. Christian F. Reisner, New York City.
 Apr. 13. — Dr. Joel E. Goldthwait, Boston.
 Apr. 20. — Rev. Joseph C. Robbins, Boston.
 Apr. 27. — Rev. Daniel Evans, Cambridge.
 Sept. 28. — Pres. Kenyon L. Butterfield, M. A. C.
 Nov. 2. — Dr. Albert Parker Fitch, Amherst.
 Nov. 9. — Rev. Herbert J. White, Hartford, Conn.
 Nov. 16. — Rev. Norman MacLeod, Hartford, Conn.
 Nov. 23. — Rabbi Sidney E. Goldstein, New York City.

TABLE VI. — *Attendance.**A. In Work of College Grade.*

CLASS.	REGISTRATION FEB. 17, 1919.			REGISTRATION NOV. 30, 1919.		
	Men.	Women.	Total.	Men.	Women.	Total.
Graduate students, . . .	9	3	12	31	2	33
Senior class, ...	64	10	74	110	3	113
Junior class, ...	69	3	72	100	3	103
Sophomore class, . . .	70	5	75	100	4	104
Provisional sophomores, . .	—	—	—	8	—	8
Freshman class, ...	93	4	97	101	9	110
Provisional freshmen, . .	25	—	25	15	—	15
Unclassified students, . .	26	3	29	24	9	33
	356	28	384	489	30	519

B. Short-course Enrollment.

	Men.	Women.	Total.
Two-year course, 1919, winter term, ¹	31	6	37
Ten weeks' course, 1919, ¹	43	20	63
First six weeks' course, 1919, ¹	13	—	13
Second six weeks' course, 1919, ...	9	1	10
Vocational poultry course, March to June, 1919, .	6	—	6
Summer school, 1919, ...	46	192	238
Summer course for Federal men, 1919, ...	31	—	31
Two-year course, 1919-20, ...	201	8	209
Vocational poultry course, 1919-20, ...	13	—	13
Rural engineering course, 1919-20, ...	16	—	16
Total, ...	409	227	636
Counted twice, ...	46	—	46
Total, ...	363	227	590

TABLE VI. — *Attendance — Concluded.*
C. Convention Registration.

	1918.	1919.
Farmers' week, ...	632	898
Polish farmers' day, ...	12	-
County agents' conference, ...	150	30
Poultry convention, ...	200	200
Boys' camps, ...	17	52
Girls' camp, ...	24	33
	1,035	1,213

TABLE VII. — *Legislative Budget, 1919.*

ITEMS.	Amount asked.	Amount granted.
Women's building and equipment, ...	\$150,000	\$127,400
Miscellaneous improvements in buildings and grounds, and teaching, operating and office equipment.	35,000	20,000
Market-garden field station, ...	15,000	15,000
Study of the grounds, ...	-	2,000
	\$200,000	\$164,400

Current Appropriations for 1918-19.

Maintenance.

Personal services: —

Administration, ...	\$30,000 00
Instruction, ...	119,000 00
General maintenance, ...	88,000 00
Experiment station, ...	38,000 00
Extension service, ...	43,000 00
Market garden, field station, ...	4,500 00
Short courses, ...	10,500 00
Travel, office and other expenses, ...	37,000 00
Teaching laboratory, supplies and equipment, ...	52,000 00

Experiment Station: —

Supplies and equipment, ...	11,500 00
Travel and office expenses, ...	5,000 00
Extension service, supplies, equipment, travel, etc., ...	35,000 00
Short courses, ...	6,500 00
Heat, light and power, ...	45,000 00
Farm, ...	26,600 00
Repairs, ordinary, ...	7,000 00
Replacements, ...	8,000 00
Market gardening, field station, ...	3,500 00

\$570,100 00

Trustees' expenses, ...	\$900 00
Printing reports, ...	3,000 00
Commercial feedstuffs, ...	6,000 00

9,900 00

\$580,000 00

TABLE VIII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1919.**A. Home Addresses of Students (classified by Towns and Cities).*

Amherst, ... 6	Hopedale, ... 1	Pleasantville, N. Y., . . 1
Arlington, ... 2	Ipswich, ... 2	Plymouth, ... 1
Barnard, Vt., . . . 1	Lake Mohegan, N. Y., . . 1	QUINCY, ... 1
Belmont, ... 1	Lexington, ... 1	Sandwich, ... 1
BEVERLY, ... 2	Littleton, ... 1	Sharon, ... 1
BOSTON, ... 18	LYNN, ... 2	South Sbaftsbury, Vt., . . 1
Brighton, ... 1	Marshfield, ... 1	South Glastonbury, Conn., 1
BROCKTON, ... 1	Middlefield, ... 1	SPRINGFIELD, ... 2
Brookline, ... 1	MEDFORD, ... 1	Sunderland, ... 2
Buxton, Me., . . . 1	MELROSE, ... 1	Sterling, ... 1
CAMBRIDGE, ... 1	MINNEAPOLIS, MINN., . . 1	Sturbridge, ... 1
Charlton, ... 1	Milford, ... 1	Turner, Me., ... 1
CHELSEA, ... 1	Mount Kisco, N. Y., . . 1	Upton, ... 1
Cohasset, ... 1	Natick, ... 1	Uxbridge, ... 1
Dalton, ... 1	NEW BEDFORD, ... 1	WALTHAM, ... 1
Danvers, ... 1	Newfane, Vt., ... 1	Warren, ... 1
Deerfield, ... 1	NEWTON, ... 5	Watertown, ... 3
Elizabeth, N. J., . . 1	NEW YORK, N. Y., . . 1	West Bridgewater, . . 1
EVERETT, ... 2	NORTH ADAMS, ... 1	West Springfield, . . 4
Franklin, ... 1	NORTHAMPTON, ... 2	WOBURN, ... 1
Greenfield, ... 3	Oxford, ... 1	WORCESTER, ... 6
Groton, ... 1	Palmer, ... 1	Williamstown, ... 1
Hamden, Conn., . . . 1	PEABODY, ... 3	
HOLYOKE, ... 8	PITTSFIELD, ... 1	

B. Home Addresses (classified by States).

	Number.	Per Cent.		Number.	Per Cent.
Connecticut, ...	2	1.6	New Jersey, ...	1	.8
Maine, ...	2	1.6	New York, ...	4	3.2
Massachusetts, ...	112	89.6	Vermont, ...	3	2.4
Minnesota, ...	1	.8		125	100.0

C. Home Addresses (classified by Counties of Massachusetts).

	Number.	Per Cent.		Number.	Per Cent.
Barnstable, ...	1	.89	Middlesex, ...	22	19.64
Berkshire, ...	4	3.57	Norfolk, ...	6	5.36
Bristol, ...	1	.89	Plymouth, ...	4	3.57
Essex, ...	10	8.93	Suffolk, ...	20	17.86
Franklin, ...	6	5.36	Worcester, ...	15	13.39
Hampden, ...	15	13.40		112	100.00
Hampshire, ...	8	7.14			

TABLE VIII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1919* — Continued.*D. Nativity of Parents.*

	Number.	Per Cent.
Neither parent foreign born, ...	85	68.0
Both parents foreign born, ...	20	16.0
Father (only) foreign born, ...	7	5.6
Mother (only) foreign born, ...	10	8.0
No statistics, ...	3	2.4
	125	100.0

E. Education of Father.

	Number.	Per Cent.
Common school, ...	52	41.6
High school, ...	31	24.8
Business school, ...	10	8.0
College or university, ...	29	23.2
No statistics, ...	3	2.4
	125	100.0

F. Religious Census.

	MEMBERSHIP.		PREFERENCE.		TOTALS.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Baptist, ...	13	10.4	2	1.6	15	12.0
Catholic, ...	17	13.6	1	.8	18	14.4
Congregationalist, ...	28	22.4	8	6.4	36	28.8
Episcopal, ...	6	4.8	3	2.4	9	7.2
Hebrew, ...	6	4.8	2	1.6	8	6.4
Methodist, ...	3	2.4	5	4.0	8	6.4
Unitarian, ...	7	5.6	6	4.8	13	10.4
Universalist, ...	3	2.4	1	.8	4	3.2
Miscellaneous, ...	8	6.4	3	2.4	11	8.8
No statistics, ...	—	—	—	—	3	2.4
	91	72.8	31	24.8	125	100.0

TABLE VIII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1919 — Concluded.**G. Occupation of Father.*

	Number.	Per Cent.
Agriculture and horticulture, ...	29	23.2
Artisans, ...	30	24.0
Business, ...	35	28.0
Deceased or no statistics, ...	6	4.8
Miscellaneous, ...	16	12.8
Professional, ...	9	7.2
	125	100.0

H. Intended Vocation of Student.

	Number.	Per Cent.
Agriculture or horticulture (practical), ...	58	46.4
Agriculture or horticulture (professional), ...	37	29.6
Professions, ...	5	4.0
Miscellaneous, ...	10	8.0
Undecided or no statistics, ...	15	12.0
	125	100.0

I. Farm Experience.

	Number.	Per Cent.
Brought up on a farm, ...	32	25.6
Not brought up on a farm and having had no or practically no farm experience.	35	28.0
Not brought up on a farm but having had some farm experience.	58	46.4
	125	100.0

J. Miscellaneous Statistics.

Average age, ... 19.36 years.

TABLE IX. — *Cases treated at the Infirmary, Dec. 1, 1918, to Nov. 30, 1919.*

	Daily Count.	Individual.
Dec. 1, 1918, to Jan. 1, 1919:—		
House cases, ...	217	37
Out-patients, ...	72	59
January 1 to February 1:—		
House cases, ...	75	13
Out-patients, ...	25	16
February 1 to March 1:—		
House cases, ...	42	9
Out-patients, ...	49	35
March 1 to April 1:—		
House cases, ...	19	5
Out-patients, ...	32	20
April 1 to May 1:—		
House cases, ...	10	1
Out-patients, ...	25	17
May 1 to June 1:—		
House cases, ...	22	8
Out-patients, ...	47	25
June 1 to July 1:—		
House cases, ...	3	1
Out-patients, ...	42	18
July 1 to August 1:—		
House cases, ...	4	1
Out-patients, ...	11	4
September 1 to October 1:—		
House cases, ...	7	2
Out-patients, ...	25	14
October 1 to November 1:—		
House cases, ...	54	13
Out-patients, ...	137	54
November 1 to December 1:—		
House cases, ...	63	12
Out-patients, ...	107	55
Number of house cases, ...		516
Number of out-patients, ...		572
Total, ...		1,088
Number cared for in the house, ...		102
Number cared for as out-patients, ...		317
Total, ...		419

REPORT OF THE TREASURER

FOR THE FISCAL YEAR ENDING NOV. 30, 1919.

BALANCE SHEET.

	DR.	CR.
1918.		
Dec. 1. To balance on hand, ...	\$22,554 65	
1919.		
Nov. 30. To departmental income, ...	143,304 99	
Nov. 30. To receipts from State Treasurer, ...	616,877 25	
Nov. 30. To receipts from United States Treasurer, ...	99,072 68	
Nov. 30. To November schedule in transit, ...	66,413 37	
Nov. 30. Expenditures for fiscal year, ...		\$774,475 74
Nov. 30. Income transferred to State Treasurer, ...		143,304 99
Nov. 30. Balance on hand, ...		30,442 21
	\$948,222 94	\$948,222 94

STATEMENT OF LEGISLATIVE APPORTIONMENT AND EXPENDITURES FOR
FISCAL YEAR ENDING NOV. 30, 1919, AND APPORTIONMENT RE-
QUESTED FOR 1920.

	Apportionment for Last Fiscal Year.	Expenditures.	Apportionment for New Fiscal Year.
College: —			
Personal services, . . .	\$234,000 00	\$245,094 90	\$366,855 00
Maintenance, . . .	178,600 00	182,149 14	205,705 00
	\$412,600 00	\$427,244 04	\$572,560 00
Experiment Station: —			
Personal services, . . .	\$38,000 00	\$38,826 25	\$92,510 00
Maintenance, . . .	16,500 00	9,901 80	20,600 00
	54,500 00	48,728 05	113,110 00
Extension Service: —			
Personal services, . . .	\$43,000 00	\$41,805 77	\$160,260 00
Maintenance, . . .	35,000 00	27,164 70	68,130 00
	78,000 00	68,970 47	228,390 00
Short courses: —			
Personal services, . . .	\$10,500 00	\$12,233 62	\$33,975 00
Maintenance, . . .	6,500 00	5,132 41	10,300 00
	17,000 00	17,366 03	44,275 00
Market-garden and field station: —			
Personal services, . . .	\$4,500 00	\$4,666 08	\$5,400 00
Maintenance, . . .	3,500 00	1,685 87	3,000 00
	8,000 00	6,351 95	8,400 00
Totals, ...	\$570,100 00	\$568,660 54	\$966,735 00

STATEMENT OF LEGISLATIVE APPORTIONMENT AND EXPENDITURES FOR
FISCAL YEAR ENDING NOV. 30, 1919, AND APPORTIONMENT RE-
QUESTED FOR 1920 — *Concluded.*

	Apportionment for Last Fiscal Year.	Expenditures.	Apportionment for New Fiscal Year.
Trustees, travel, . . .	\$900 00	\$1,027 48	\$1,200 00
Printing reports, . . .	3,000 00	3,000 00	6,000 00
Commercial feedstuffs, . .	6,000 00	6,000 00	6,000 00
Totals, . . .	\$580,000 00	\$578,688 02	\$979,935 00
Fertilizer law, . . .	10,500 00	11,548 68	12,500 00
Poultry disease law, . . .	2,000 00	813 66	4,000 00
Milk testing law, . . .	500 00	616 69	550 00
Totals, . . .	\$593,000 00	\$591,667 05	\$996,985 00

CASH STATEMENT.

	Other Funds.	State Funds.	Totals.
Balance Dec. 1, 1918, ...	\$22,554 65	-	\$22,554 65
<i>Receipts.</i>			
College receipts from students and others, ...	-	-	16,401 48
Tuition, ...	-	\$2,595 22	
Laboratory fees, ...	-	6,486 63	
Rents, ...	-	7,319 63	
Department sales, ...	-	-	112,271 72
Produce, ...	-	105,396 25	
Miscellaneous, ...	-	6,875 47	
Experiment Station, ...	-	-	8,752 05
Cranberry receipts, ...	-	4,234 46	
Chemical receipts, ...	-	1,604 86	
Miscellaneous, ...	-	2,912 73	
Extension Service, ...	-	-	1,185 13
Correspondence courses, ...	-	612 00	
Miscellaneous, ...	-	573 13	
Short courses, ...	-	-	1,898 63
Students' fees, ...	-	1,467 75	
Summer school, ...	-	35 28	
Winter school, ...	-	395 60	
Market-garden field station, ...	-	-	2,795 98
Produce, ...	-	2,795 98	
Treasurer of the Commonwealth, ...	-	-	616,877 25
Maintenance, ...	-	509,084 87	
Special appropriations, ...	-	104,479 06	
Endowment, ...	3,313 32	-	
Federal government, ...	-	-	99,072 68
Land grant of 1862, ...	7,300 00	-	
Hatch fund of 1887, ...	15,000 00	-	
Morrill fund of 1890, ...	16,848 67	-	
Adams fund of 1906, ...	15,000 00	-	
Nelson fund of 1907, ...	16,848 66	-	
Smith Lever fund of 1914, ...	25,392 19	-	
S. A. T. C., plumbing, ...	2,683 16	-	
November schedule in transit, ...	-	66,413 37	66,413 37
	\$124,940 65	\$823,282 29	\$948,222 94

CASH STATEMENT — *Concluded.*

	Other Funds.	State Funds.	Totals.
<i>Payments.</i>			
College expenses, ...			\$468,019 62
Personal services, ...	\$37,864 69	\$245,094 90	
Maintenance, ...	2,910 89	182,149 14	
Experiment Station, ...			78,423 14
Personal services, ...	28,133 59	38,826 25	
Maintenance, ...	1,561 50	9,901 80	
Extension Service, ...			92,357 05
Personal services, ...	17,734 01	41,805 77	
Maintenance, ...	5,652 57	27,164 70	
Short courses, ...			17,366 03
Personal services, ...	—	12,233 62	
Maintenance, ...	—	5,132 41	
Market-garden field station, ...			6,351 95
Personal services, ...	—	4,666 08	
Maintenance, ...	—	1,685 87	
Special appropriations, ...			111,957 95
Feed law, ...	—	6,000 00	
1914, agricultural building, ...	—	925 35	
1917, improvements and equipment, ...	—	2,231 00	
1917, power plant, ...	—	3,029 22	
1917, printing reports, ...	—	888 79	
1918, improvements and equipment, ...	—	11,448 39	
1918, power plant, ...	—	49,697 74	
1918, market-garden field station, ...	—	7,235 49	
1918, dining hall, ...	—	2,173 87	
1918, printing reports, ...	—	3,000 00	
Printing, ...	—	158 17	
1919, improvements and equipment, ...	—	10,443 74	
1919, women's dormitory, ...	—	6,016 07	
1919, market-garden field station, ...	—	4,348 73	
1919, engineering survey, ...	—	832 27	
Trustees, travel, ...	—	1,027 48	
S. A. T. C., plumbing, ...	2,501 64	—	
Income, ...	—	143,304 99	143,304 99
Balance, ...	30,442 21	—	30,442 21
	\$126,801 10	\$821,421 84	\$948,222 94

CLASSIFICATION OF INCOME FROM STUDENTS AND OTHERS.

	Laboratory Fees.	Department Sales.	Transfers.	Rent.	Miscellaneous.	Tuition.	Totals.
Agricultural economics,	-	-	-	-	\$1 22	-	\$1 22
Agricultural education,	-	-	-	-	10	-	10
Agromony,	\$252 00	-	-	-	-	-	252 00
Animal husbandry,	293 50	-	-	-	70	-	294 20
Botany,	620 00	-	-	-	7 76	-	627 76
Chemistry,	2,652 88	-	-	-	-	-	2,669 42
Dairying,	331 50	\$32,970 24	\$16 54	-	20	-	33,301 94
Domestic science,	-	-	-	-	68	-	68
Entomology,	82 00	788 32	212 18	-	-	-	1,082 50
Farm,	-	42,166 18	2,072 29	-	-	-	44,238 47
Farm management,	195 50	-	-	-	10	-	195 60
Floriculture,	68 50	4,477 49	-	\$4 00	-	-	4,549 99
Forestry,	9 00	-	-	-	-	-	9 00
Freshman agriculture,	219 00	-	-	-	-	-	219 00
General agriculture,	-	-	-	-	4 15	-	4 15
General horticulture,	-	-	1,840 90	-	398 36	-	2,248 26
Grounds,	-	-	24 50	-	82 63	-	107 13
Horticultural manufactures,	-	641 03	-	-	-	-	641 03

Hospital, ...	-	-	-	-	792 48	-	792 48
Landscape gardening, ...	218 00	-	-	30 24	-	-	248 24
Language and literature, ...	170 00	-	-	-	-	-	170 00
Library, ...	-	59 34	-	-	-	-	59 34
Market gardening, ...	76 00	4,728 51	-	-	-	-	4,804 51
Mathematics, ...	232 81	-	-	-	-	-	232 81
Microbiology, ...	307 00	-	-	-	397 60	-	704 60
Mount Toby, ...	-	5,872 15	-	-	-	-	5,872 15
Physics, ...	21 00	-	-	19 00	05	-	40 05
Pomology, ...	135 00	3,603 61	-	-	-	-	3,738 61
Poultry husbandry, ...	114 00	15,719 10	-	-	62 64	-	15,895 74
Rural engineering, ...	214 14	-	-	-	-	-	214 14
Veterinary, ...	6 00	-	-	-	-	-	6 00
War emergency, ...	-	844 62	-	-	-	-	844 62
Zoology and geology, ...	511 00	-	-	4 63	50	-	516 13
Operating and maintenance, ...	-	-	-	-	3,562 48	82,505 22	6,187 70
North dormitory, ...	-	-	-	-	-	-	2,574 42
South dormitory, ...	-	-	-	-	-	-	2,395 04
College residences, ...	-	-	-	-	745 72	-	745 72

CLASSIFICATION OF INCOME FROM STUDENTS AND OTHERS — *Concluded.*

	Laboratory Fees.	Department Sales.	Transfers.	Rent.	Miscellaneous.	Tuition.	Totals.
Dean's office, ...	-	-	-	-	\$0 55	-	\$0 55
President's office, ...	-	-	-	-	3 50	-	3 50
Registrar's office, ...	-	-	-	-	25	-	25
Treasurer's office, ...	-	-	-	-	64 55	-	64 55
Draper Hall, ...	-	-	-	\$1,624 75	-	-	1,624 75
General expense (cash credits), ...	-	-	-	-	1,494 97	-	1,494 97
Totals, ...	\$6,728 83	\$111,870 59	\$4,210 28	\$7,392 93	\$6,875 47	\$2,595 22	\$139,673 32
Less refunds (\$315.50) and journal entries (\$10,684.62),	242 20	10,684 62	-	73 30	-	-	11,000 12
	\$6,486 63	\$101,185 97	\$4,210 28	\$7,319 63	\$6,875 47	\$2,595 22	\$128,673 20

ANALYSIS OF COLLEGE EXPENDITURES.

ADMINISTRATION.	Office Expense.	Salaries and Labor.	Travel.	Minor Equip- ment.	Building Supplies.	Publicity and Lectures.	Student Activities.	Com- mence- ment.	Miscel- laneous.	Totals.
Dean's office, ...	\$334 71	\$124 89	\$2 20	\$50 70	-	-	-	-	-	\$522 50
Executive order, ...	-	-	2,663 44	-	-	\$1,454 79	\$87 50	\$754 43	\$2,125 07	7,085 23
President's office, ...	1,309 16	248 86	302 53	58 42	\$12 36	-	-	-	40 25	1,971 58
Registrar's office, ...	472 50	65 90	61 39	79	-	-	-	-	-	600 58
Treasurer's office, ...	864 14	213 49	223 38	161 58	44 81	-	-	-	32 82	1,540 22
Administration (salaries), ...	-	31,743 14	-	-	-	-	-	-	-	31,743 14
Totals, ...	\$2,980 51	\$32,406 28	\$3,252 94	\$271 49	\$57 17	\$1,454 79	\$87 50	\$754 43	\$2,198 14	\$43,463 25

MAINTENANCE.	Office Expense.	Labor.	Laboratory Supplies.	Refunds.	Minor Equip- ment.	Building Supplies.	Travel.	General Expense.	Miscel- laneous.	Salaries.	Totals.
Academic maintenance:—											
Agricultural economics, ...	\$155 37	\$67 91	\$6 60	-	\$46 84	\$0 28	\$100 98	-	-	-	\$377 98
Agricultural education, ...	134 05	-	44 56	-	35 55	-	50 09	-	-	-	264 25
Agromony, ...	199 38	286 36	219 43	\$1 50	139 41	-	101 86	-	-	-	947 94
Animal husbandry, ...	211 78	153 50	53 11	6 00	53 76	-	259 00	-	-	-	742 75
Botany, ...	261 93	625 96	440 58	3 50	1 03	149 78	-	-	-	-	1,482 78
Chemistry, ...	155 37	967 10	3,310 60	83 30	35 26	76 15	8 84	-	-	-	4,636 62

ANALYSIS OF COLLEGE EXPENDITURES — *Concluded.*

MAINTENANCE.	Office Expense.	Labor.	Laboratory Supplies.	Refunds.	Minor Equip- ment.	Building Supplies.	Travel.	General Expense.	Miscel- laneous.	Salaries.	Totals.
Dairying, ...	\$217 50	\$3,910 05	\$28,953 89	\$14 50	\$317 84	\$131 51	\$5 41	-	-	-	\$33,550 70
Domestic science, ...	234 39	671 03	200 91	-	1,017 80	119 74	153 40	-	-	-	2,307 27
Economics and sociology, .	47 60	8 00	10 18	-	-	-	-	-	-	-	65 78
Entomology, ...	84 75	510 13	166 23	-	33 36	149 40	-	-	-	-	943 87
Farm management, ...	153 12	22 64	68 36	1 50	5 97	-	106 73	-	-	-	358 32
Floriculture, ...	38 94	5,968 32	1,413 26	-	22 80	25 08	-	-	-	-	7,468 40
Forestry, ...	73 96	95 79	11 55	-	41 08	6 96	108 45	-	-	-	337 79
Freshman agriculture, . . .	20 12	33 81	110 45	-	24 22	-	-	-	-	-	188 60
General agriculture, ...	-	1,506 86	-	-	176 65	238 44	-	-	\$79 20	-	2,001 15
Horticultural manufactures, .	49 67	1,155 21	1,933 53	-	224 15	-	66 57	-	-	-	3,429 13
Hospital, ...	-	1,225 78	-	-	36 11	-	-	\$950 36	-	-	2,212 25
Landscape gardening, . . .	18 86	-	117 37	3 00	30 21	-	-	-	-	-	169 44
Language and literature, . .	11 00	24 28	113 73	20 00	41 05	-	-	-	-	-	210 06
Market gardening, ...	161 42	5,907 94	1,433 86	6 50	117 15	36 19	229 36	-	-	-	7,892 42
Mathematics, ...	55 24	109 07	12 27	-	25 00	19 28	-	-	-	-	220 86
Microbiology, ...	99 20	577 08	770 93	81 90	261 41	35 38	-	-	-	-	1,825 90
Military science, ...	107 71	705 71	3 85	-	225 61	221 09	-	123 80	-	-	1,387 77
Mount Toby, ...	-	2,970 85	-	-	181 35	-	131 34	-	88 80	-	3,372 34
Physical education, ...	35 17	281 15	211 90	-	52	-	312 53	-	-	-	841 27
Physics, ...	37 56	271 22	209 12	-	156 84	47 50	-	-	-	-	722 24
Pomology, ...	196 22	3,226 08	953 04	5 00	108 05	-	61 79	-	-	-	4,550 18

[illegible]

CURRENT ACCOUNTS.

Disbursements and Receipts.

ACCOUNTS.	Disbursements from Nov. 30, 1918, to Nov. 30, 1919.	Receipts from Nov. 30, 1918, to Nov. 30, 1919.	Apportionment for Year ending Nov. 30, 1919.	Balance to Credit.
Administration:—				
Dean's office, ...	\$522 50	\$0 55	\$500 00	—\$22 50
Executive order, ...	7,085 23	—	6,700 00	—385 23
President's office, ...	1,971 58	3 50	1,500 00	—471 58
Registrar's office, ...	600 58	25	600 00	—58
Salaries, ...	31,743 14	—	30,000 00	—1,743 14
Treasurer's office, ...	1,540 22	64 55	1,200 00	—340 22
Maintenance, academic:—				
Agricultural economics, ...	377 98	1 22	338 50	—39 48
Agricultural education, ...	264 25	10	350 00	85 75
Agronomy, ...	947 94	252 00	975 00	27 06
Animal husbandry, ...	742 75	294 20	610 00	—132 75
Botany, ...	1,482 78	627 76	1,600 00	117 22
Chemistry, ...	4,636 62	2,669 42	4,450 00	—186 62
Dairying, ...	33,550 70	33,301 94	33,665 00	114 30
Domestic science, ...	2,397 27	68	500 00	—1,897 27
Economics and sociology, ...	65 78	—	50 00	—15 78
Entomology, ...	943 87	1,082 50	1,000 00	56 13
Farm management, ...	358 32	195 60	400 00	41 68
Floriculture, ...	7,468 40	4,549 99	6,850 00	—618 40
Forestry, ...	337 79	9 00	250 00	—87 79
Freshman agriculture, ...	188 60	219 00	300 00	111 40
General agriculture, ...	2,001 15	4 15	1,750 00	—251 15
Horticultural manufactures, ...	3,429 13	641 03	2,665 00	—764 13
Hospital, ...	2,212 25	792 48	1,800 00	—412 25
Landscape gardening, ...	169 44	248 24	350 00	180 56
Language and literature, ...	210 06	170 00	400 00	189 94
Market gardening, ...	7,892 42	4,804 51	4,700 00	—3,192 42
Mathematics, ...	220 86	232 81	220 00	—86
Microbiology, ...	1,825 90	704 60	1,725 00	—100 90
Military science, ...	1,387 77	—	1,460 00	72 23
Mount Toby, ...	3,372 34	5,872 15	5,000 00	1,627 66
Physical education, ...	841 27	—	700 00	—141 27
Physics, ...	722 24	40 05	600 00	—122 24
Pomology, ...	4,550 18	3,733 61	3,935 00	—615 18
Poultry husbandry, ...	16,248 47	15,895 74	16,075 00	—173 47
Rural engineering, ...	742 47	214 14	575 00	—167 47
Rural sociology, ...	174 96	—	150 00	—24 96
Veterinary, ...	895 21	6 00	1,100 00	204 79
War emergency, ...	102 62	844 62	—	742 00
Zoölogy and geology, ...	655 34	516 13	575 00	—80 34
Maintenance, general:—				
Farm, ...	50,997 36	44,238 47	46,600 00	—4,437 72
General horticulture, ...	9,117 97	2,248 26	8,800 00	—317 97
Graduate school, ...	60 26	—	100 00	39 74
Grounds, ...	5,731 00	107 13	5,800 00	69 00
Library, ...	6,919 64	59 34	6,036 50	—883 14
General expense, ...	31,350 07	31,350 07	—	—
Operating and maintenance, ...	98,123 29	13,527 63	90,000 00	—8,082 93
Endowment fund, ...	7,220 76	10,613 32	10,613 32	3,392 56
Instruction:—				
Salaries, ...	121,518 21	—	130,000 00	8,481 79
United States Treasurer, Morrill fund (\$16,666.67 and \$182 refund), ...	16,777 42	16,848 67	16,666 67	9,793 47
United States Treasurer, Nelson fund (\$16,666.67 and \$182 refund), ...	16,777 40	16,848 66	16,666 66	9,793 48
State Treasurer, account of schedules, ...	—	427,244 04	—	—
Income to State Treasurer, ...	128,673 20	—	—	—
	\$638,146 96	\$641,083 11	\$466,901 65	\$9,431 02
Less journal entries (\$40,539.72) and refunds (\$914.42), ...	41,454 14	—	—	—
Less journal entries (\$40,539.72) and refunds (\$315.50), ...	—	40,855 22	—	—
	\$596,692 82	\$600,227 89	—	—
Balance beginning fiscal year Dec. 1, 1918, ...	—	19,444 44	—	—
Balance on hand Nov. 30, 1919, ...	22,979 51	—	—	—
	\$619,672 33	\$619,672 33	—	—

COLLEGE ACCOUNTS.

Comparative Disbursements and Receipts for 1918-19.

ACCOUNTS.	DISBURSEMENTS.		RECEIPTS.	
	1918.	1919.	1918.	1919.
Agricultural economics, ...	\$262 55	\$377 98	-	\$1 22
Agricultural education, ...	323 67	264 25	-	10
Agronomy, ...	772 83	947 94	\$199 12	252 00
Animal husbandry, ...	376 50	742 75	139 50	294 20
Beekeeping, ...	1,025 52	-	588 12	-
Botany, ...	1,377 19	1,482 78	320 50	627 76
Chemistry, ...	3,093 18	4,636 62	1,545 92	2,669 42
Dairying, ...	31,821 36	33,550 70	26,479 19	33,301 94
Dean's office, ...	388 40	522 50	43 43	55
Domestic science, ...	-	2,397 27	-	68
Economics and sociology, ...	74 65	65 78	-	-
Entomology, ...	393 08	943 87	25 90	1,082 50
Executive order, ...	5,649 07	7,085 23	14 91	-
Farm management, ...	349 61	358 32	138 56	195 60
Farm, ...	47,778 65	50,997 36	41,988 56	44,238 47
Floriculture, ...	5,873 28	7,468 40	2,407 98	4,549 99
Forestry, ...	120 81	337 79	7 00	9 00
Freshman agriculture, ...	88 54	188 60	238 55	219 00
General agriculture, ...	1,538 01	2,001 15	75	4 15
General horticulture, ...	8,326 81	9,117 97	2,671 87	2,248 26
Graduate school, ...	82 57	60 26	-	-
Grounds, ...	4,780 99	5,731 00	92 24	107 13
Horticultural manufactures, ...	1,893 63	3,429 13	374 33	641 03
Hospital, ...	1,565 61	2,212 25	280 32	792 48
Land, ...	5,000 00	-	5,000 00	-
Landscape gardening, ...	178 53	169 44	157 71	248 24
Language and literature, ...	382 73	210 06	112 00	170 00
Library, ...	6,238 82	6,919 64	480 07	59 34
Market gardening, ...	5,037 99	7,892 42	3,423 29	4,804 51
Market garden field station, ...	1,121 94	-	2,317 46	-
Mathematics, ...	151 21	220 86	60 10	232 81
Military science, ...	1,003 49	1,387 77	89 41	-
Microbiology, ...	836 54	1,825 90	434 45	704 60
Mount Toby, ...	7,139 81	3,372 34	357 00	5,872 15
Physical education, ...	452 64	841 27	-	-
Physics, ...	556 60	722 24	76 00	40 05
Pomology, ...	3,340 64	4,550 18	2,635 05	3,738 61
Poultry husbandry, ...	16,812 64	16,248 47	16,449 05	15,895 74
President's office, ...	1,828 64	1,971 58	26 00	3 50
Registrar's office, ...	592 26	600 58	-	25
Rural engineering, ...	544 47	742 47	191 00	214 14
Rural sociology, ...	101 87	174 96	-	-
Salaries, ...	170,048 15	153,261 35	676 81	-
Treasurer's office, ...	1,184 60	1,540 22	-	64 55
Veterinary science, ...	920 54	895 21	20 12	6 00
War emergency, ...	2,236 28	102 62	2,042 51	844 62
Women's dormitories, ...	724 71	-	542 00	-
Zoölogy and geology, ...	243 55	655 34	175 38	516 13
1917 celebration, ...	1,751 94	-	-	-
General expense, ...	-	31,350 07	-	31,350 07
Operating and maintenance, ...	86,129 77	98,123 29	9,628 37	13,527 63
State Treasurer: —				
Endowment fund, ...	-	7,220 76	10,613 32	10,613 32
Graduate school, ...	-	-	3,000 00	-
Maintenance, ...	-	-	110,000 00	-
Instruction, ...	-	-	115,000 00	-
Administration, ...	-	-	39,000 00	-
United States Treasurer: —				
Morrill fund (\$16,666.67 and \$182 re-	-	16,777 42	16,666 66	16,848 67
fund), ...				
Nelson fund (\$16,666.66 and \$182 re-	-	16,777 40	16,666 67	16,848 66
fund), ...				
State Treasurer account of schedules,	-	-	-	427,244 04
Income to State Treasurer, ...	-	128,673 20	-	-
	\$432,516 87	\$638,146 96	\$433,397 18	\$641,083 11
Less journal entries and refunds, ...	-	41,454 14	-	40,855 22
	\$432,516 87	\$596,692 82	\$433,397 18	\$600,227 89
Balance beginning of fiscal year, ...	-	-	18,266 00	19,444 44
Balance on hand at close of				
fiscal year, ...	19,146 31	22,979 51	-	-
	\$451,663 18	\$619,672 33	\$451,663 18	\$619,672 33

COLLEGE ACCOUNTS — *Concluded.**Summary.*

	Disbursements.	Receipts.
Cash on hand Dec. 1, 1918, ...	—	\$19,444 44
Institution receipts Nov. 30, 1919, ...	—	128,673 20
State Treasurer's receipts Nov. 30, 1919, ...	—	427,244 04
United States Treasurer's receipts Nov. 30, 1919, ...	—	33,697 33
State Treasurer, endowment fund, ...	—	10,613 32
Total disbursements, ...	\$468,019 62	—
Receipts turned in to State Treasurer, ...	128,673 20	—
	\$596,692 82 ²	\$619,672 33
Bills receivable Dec. 1, 1918, deducted, ...	—	5,972 27
Bills payable Dec. 1, 1918, deducted, ...	7,961 55	—
	\$588,731 27	\$613,700 06
Bills receivable Nov. 30, 1919, ...	—	8,206 00
Bills payable Nov. 30, 1919, ...	7,179 90	—
Balance, ...	25,994 39	—
	\$621,906 06	\$621,906 06

FARM DISBURSEMENTS.

	Labor.	Equip- ment.	Feed.	Supplies.	Sundry.	Bedding.	Fertilizer.	Seeds.	Improve- ments.	Totals.
Dairy cattle, ...	\$10,067 59	\$562 39	\$2,731 54	\$1,768 45	\$764 14	-	-	-	-	\$15,884 11
Horses, ...	2,033 75	236 18	163 05	25 45	361 23	-	-	-	-	2,850 66
Sheep, ...	976 26	50 38	133 24	33 40	126 36	-	-	-	-	1,319 74
Live stock, ...	314 58	-	11,279 66	-	-	\$1,040 66	-	-	-	12,634 90
Swine, ...	1,025 59	92 82	1,605 19	-	76 30	-	-	-	-	2,799 90
Field crops, ...	5,057 13	-	-	77 81	-	-	\$1,042 00	\$875 32	-	7,052 26
Tools and machinery, ...	570 97	1,142 73	-	295 66	-	-	-	-	-	2,009 36
Miscellaneous, ...	4,129 67	-	-	221 44	-	-	-	-	\$2,095 32	6,446 43
Totals, ...	\$24,175 54	\$2,034 50	\$15,942 78	\$2,413 21	\$1,328 03	\$1,040 66	\$1,042 00	\$875 32	\$2,095 32	\$50,997 36

FARM CREDITS.

	Milk.	Stock.	Sundry.	Labor.	Live Stock.	Field Crops.	Tools and Machinery.	Improve- ments.	Totals.
Dairy cattle, ...	\$31,155 08	\$3,264 24	\$361 45	-	-	-	-	-	\$34,780 77
Horses, ...	-	455 00	10 85	\$937 66	-	-	-	-	1,403 51
Sheep, ...	-	1,092 19	-	-	-	-	-	-	1,092 19
Live stock, ...	-	-	-	-	\$150 75	-	-	-	150 75
Swine, ...	-	3,075 27	-	-	-	-	-	-	3,075 27
Field crops, ...	-	-	-	-	-	\$2,391 88	-	-	2,391 88
Tools and machinery, ...	-	-	-	1,134 63	-	-	\$51 72	-	31 72
Miscellaneous, ...	-	-	-	-	-	-	-	\$157 75	1,292 38
Totals, ...	\$31,155 08	\$7,886 70	\$372 30	\$2,072 29	\$150 75	\$2,391 88	\$51 72	\$157 75	\$44,238 47

AGRICULTURAL DIVISION.
Disbursements and Receipts.

	Disbursements.	Receipts.
Agronomy, ...	\$947 94	\$252 00
Animal husbandry, ...	742 75	294 20
Dairying, ...	33,550 70	33,301 94
Farm, ...	50,997 36	44,238 47
Farm management, ...	358 32	195 60
Poultry husbandry, ...	16,248 47	15,895 74
Rural engineering, ...	742 47	214 14
Division totals, ...	\$103,588 01	\$94,392 09

Summary.

	DR.	CR.
By total division receipts, ...		\$94,392 09
By bills receivable, ...		5,652 57
By net apportionment, ...		4,507 91
By total disbursements, ...	\$103,588 01	
To bills payable, ...	4,335 74	
Balance, ...		3,371 18
	\$107,923 75	\$107,923 75

Inventory of Quick Assets.

	Nov. 30, 1918.	Nov. 30, 1919.
Inventory of produce, ...	\$10,550 24	\$14,967 85
Inventory of cattle, ...	17,100 00	17,090 00
Inventory of swine, ...	1,957 00	1,507 00
Inventory of horses, ...	4,675 00	4,350 00
Inventory of poultry, ...	2,682 10	2,946 10
Inventory of sheep, ...	1,655 00	2,010 00
	\$38,619 34	\$42,870 95

HORTICULTURAL DIVISION.

Disbursements and Receipts.

	Disbursements.	Receipts.
Floriculture, ...	\$7,468 40	\$4,549 99
Forestry, ...	337 79	9 00
General horticulture, ...	9,117 97	2,248 26
Grounds, ...	5,731 00	107 13
Horticultural manufactures, ...	3,429 13	641 03
Landscape gardening, ...	169 44	248 24
Market gardening, ...	7,892 42	4,804 51
Pomology, ...	4,550 18	3,738 61
Mount Toby, ...	3,372 34	5,872 15
	\$42,068 67	\$22,218 92

Summary.

	Dr.	Cr.
By total division receipts, ...		\$22,218 92
By bills receivable, ...		2,043 99
By net apportionment, ...		16,131 08
To total division disbursements, ...	\$42,068 67	
To bills payable, ...	551 68	
By balance, ...		2,226 36
	\$42,620 35	\$42,620 35

Inventory of Quick Assets.

	Nov. 30, 1918.	Nov. 30, 1919.
Floriculture, ...	\$1,200 00	\$1,200 00
General horticulture (live stock), ...	1,663 00	1,995 00
Horticultural manufactures, ...	—	200 00
Market gardening, ...	805 00	175 50
Mount Toby, ...	9,260 00	4,790 22
Pomology, ...	1,181 00	455 00
	\$14,109 00	\$8,815 72

EXPENSE OPERATING AND MAINTENANCE.

	Salaries.	Labor.	Fuel and Water.	Repairs.	Supplies.	Tools.	Architect.	Miscellaneous.	Totals.
General:—									
General superintendent,	\$2,572 18	—	—	—	—	—	—	—	\$2,572 18
Office,	810 00	—	—	—	\$283 36	—	—	—	1,093 36
General expense,	—	—	—	—	40 36	—	—	—	40 36
Power plant:—									
Heat,	—	\$10,757 39	\$46,926 78	\$3,403 67	—	—	—	—	61,087 84
Light,	—	2,136 25	—	899 73	—	—	—	—	3,035 98
Tools,	—	—	2,307 73	—	—	\$392 67	—	—	892 67
Amherst Water Company,	—	1,688 49	—	—	—	—	—	—	2,307 73
Night watchman,	—	301 96	—	—	—	—	—	—	1,688 49
Mail service,	—	510 82	—	—	—	—	—	—	301 96
Water mains,	—	1,935 45	—	—	—	—	—	—	510 82
Steam mains,	—	1,851 64	—	—	—	—	—	—	1,935 45
Electric light circuit,	—	—	—	—	—	—	—	—	1,851 64
Miscellaneous sundry,	—	55 68	—	—	—	—	—	\$3,934 31	3,934 31
Sewers and cesspools,	—	365 79	—	—	—	—	—	—	55 68
Walks and drives,	—	1,135 03	—	—	102 81	—	—	967 39	365 79
Emergency maintenance,	—	—	—	—	—	—	\$684 97	—	2,205 23
Expert service,	—	—	—	—	47 15	—	—	—	684 97
Fire department,	—	—	—	—	—	—	—	—	47 15
Totals,	\$3,352 18	\$20,738 50	\$49,234 51	\$4,303 40	\$473 68	\$892 67	\$684 97	\$4,901 70	\$84,611 61

EXPERIMENT STATION.
Disbursements and Receipts.

ACCOUNTS.	Disbursements from Dec. 1, 1918, to Nov. 30, 1919.	Receipts from Dec. 1, 1918, to Nov. 30, 1919.	Apportionment for Year ending Nov. 30, 1919.	Balance to Credit.
Administration, ...	\$835 87	\$1 00	\$1,100 00	\$264 13
Agricultural, ...	9,205 27	4,908 59	7,000 00	—2,205 27
Agricultural economics, ...	699 16	—	800 00	100 94
Botanical, ...	1,967 65	—	2,000 00	32 35
Chemical, ...	4,991 27	3,820 67	5,000 00	8 73
Cranberry, ...	3,618 41	4,234 46	4,100 00	481 59
Entomological, ...	605 48	4 55	650 00	44 52
Freight and express, ...	353 38	—	400 00	46 62
Horticultural, ...	1,603 09	100 25	2,000 00	396 91
Library, ...	742 17	—	600 00	—142 17
Meteorology, ...	321 96	—	400 00	78 04
Microbiology, ...	1,258 22	—	1,300 00	41 78
Poultry, ...	2,355 95	32 70	2,400 00	44 05
Publications, ...	1,374 62	—	800 00	—574 62
Salaries, ...	50,753 50	—	49,066 00	—1,687 50
Tillson farm, ...	2,340 73	1,259 91	2,500 00	159 27
Treasurer's office, ...	341 37	—	350 00	8 63
Veterinary, ...	813 66	148 54	500 00	—313 66
Hatch fund, ...	—	15,000 00	—	—
Adams fund, ...	—	15,000 00	—	—
State Treasurer, account of schedules,	—	48,728 05	—	—
Income remitted to State Treasurer,	8,752 05	—	—	—
	\$92,933 81	\$93,238 72	\$80,966 00	—\$3,215 66
Less journal entries, ...	5,758 62	5,758 62	—	—
	\$87,175 19	\$87,480 10	—	—
Balance beginning fiscal year Dec. 1, 1918,	—	2,534 07	—	—
Balance on hand Nov. 30, 1919, . . .	2,838 98	—	—	—
Totals, ...	\$90,014 17	\$90,014 17	—	—

EXPERIMENT STATION — *Continued.**Comparative Disbursements and Receipts, 1918-19.*

ACCOUNTS.	DISBURSEMENTS.		RECEIPTS.	
	1918.	1919.	1918.	1919.
Administration, ...	\$888 49	\$835 87	\$40 65	\$1 00
Agriculture, ...	9,627 26	9,205 27	6,064 36	4,908 59
Agricultural economics, ...	355 71	699 16	-	-
Botanical, ...	2,202 50	1,967 65	-	-
Chemical, ...	14,641 14	4,991 27	13,423 39	3,820 67
Cranberry, ...	5,705 37	3,618 41	6,220 20	4,234 46
Entomological, ...	603 71	605 48	-	4 55
Equipment, ...	11 00	-	-	-
Feed inspection, ...	6,925 28	-	6,053 00	-
Fertilizer inspection, ...	9,519 67	-	7,007 50	-
Freight and express, ...	334 71	353 38	8 65	-
Graves orchard, ...	126 38	-	1,004 50	-
Horticultural, ...	2,142 69	1,603 09	61 66	100 25
Library, ...	218 39	742 17	-	-
Meteorology, ...	325 82	321 96	-	-
Microbiology, ...	947 61	1,258 22	-	-
Poultry, ...	2,316 15	2,355 95	19 63	32 70
Pomology, ...	-	-	3 40	-
Publications, ...	247 94	1,374 62	-	-
Salaries, ...	47,123 30	50,753 50	-	-
Tillson farm, ...	3,390 51	2,340 73	1,010 94	1,259 91
Treasurer's office, ...	246 46	341 37	-	-
Veterinary, ...	270 98	813 66	206 35	148 54
Hatch fund, ...	-	-	15,000 00	15,000 00
Adams fund, ...	-	-	15,000 00	15,000 00
State fund, ...	-	-	40,000 00	-
State Treasurer, account of schedules,	-	-	-	48,728 05
Income remitted to State Treasurer,	-	8,752 05	-	-
	\$108,171 07	\$92,933 81	\$111,124 23	\$93,238 72
Less journal entries, ...	-	5,758 62	-	5,758 62
	\$108,171 07	\$87,175 19	\$111,124 23	\$87,480 10
Balance beginning of fiscal year, .	-	-	8,688 34	2,534 07
Balance on hand at close of fiscal year,	11,641 50	2,838 98	-	-
Totals, ...	\$119,812 57	\$90,014 17	\$119,812 57	\$90,014 17

EXPERIMENT STATION — *Concluded.*
Analysis of Experiment Station Accounts.

	Adams Fund.	Hatch Fund.	State Fund.	Totals.
Salaries, ...	\$13,290 83	\$14,173 57	\$23,289 10	\$50,753 50
Labor, ...	504 96	164 23	18,187 82	18,857 01
Publications, ...	—	—	934 49	934 49
Postage and stationery, ...	—	80 50	1,324 14	1,404 64
Freight and express, ...	—	—	418 93	418 93
Heat, light, water and power, ...	—	—	287 36	287 36
Chemical and laboratory supplies, ...	193 96	—	1,001 40	1,195 36
Seeds, plants and sundry supplies, ...	96 14	—	1,788 36	1,884 50
Fertilizers, ...	115 20	203 65	888 48	1,207 33
Feedstuffs, ...	201 25	—	1,744 45	1,945 70
Library, ...	—	20 00	745 07	765 07
Tools, machinery and appliances, ...	—	—	541 38	541 38
Furniture and fixtures, ...	—	—	184 01	184 01
Scientific apparatus and specimens, ...	535 30	115 50	149 85	800 65
Live stock, ...	—	—	107 00	107 00
Traveling expenses, ...	—	—	1,785 70	1,785 70
Buildings and land, ...	—	—	1,109 13	1,109 13
Totals, ...	\$14,937 64	\$14,757 45	\$54,486 67	\$84,181 76
Less journals, ...	—	—	5,758 62	5,758 62
	\$14,937 64	\$14,757 45	\$48,728 05	\$78,423 14

Summary.

	Disbursements.	Receipts.
Cash on hand Dec. 1, 1918, ...	—	\$2,534 07
Receipts from State Treasurer, ...	—	48,728 05
Receipts from United States Treasurer, ...	—	30,000 00
Receipts from other sources, ...	—	8,752 05
Total disbursements, ...	\$78,423 14	—
Receipts turned into State Treasurer, ...	8,752 05	—
	\$87,175 19	\$90,014 17
Bills receivable Dec. 1, 1918, deducted, ...	—	2,599 44
Bills payable Dec. 1, 1918, deducted, ...	424 64	—
	\$86,750 55	\$87,414 73
Bills receivable Nov. 30, 1919, ...	—	770 44
Bills payable Nov. 30, 1919, ...	954 14	—
Balance, ...	480 48	—
	\$88,185 17	\$88,185 17

EXTENSION SERVICE.¹
Disbursements and Receipts.

CLASSIFICATION.	Disbursements.	Receipts.	Apportionment.	Balance.
Administration, ...	\$1,256 95	-	\$2,000 00	\$743 05
Animal husbandry, ...	837 04	-	1,000 00	162 96
Co-operative marketing, ...	1,279 44	-	1,200 00	-79 44
Correspondence courses, ...	773 70	\$612 00	1,600 00	826 30
County agents' work, ...	957 29	-	200 00	-757 29
Dairying, ...	1,264 42	-	1,200 00	-64 42
Director's office, ...	3,739 13	772 97	2,700 00	-1,039 13
Exhibits, ...	4,028 26	-	2,000 00	-2,028 26
Expenses, urban home demonstration, .	580 06	35	1,475 00	894 94
Extension courses at college, ...	1,758 11	9 52	3,800 00	2,041 89
Extension schools, ...	62 32	-	-	-62 32
Farm management demonstration, . .	369 74	111 68	250 00	-119 74
Home economics, ...	2,081 68	43 20	300 00	-1,781 68
Home gardening, ...	270 33	-	940 00	669 67
Horticultural manufactures, ...	1,635 57	2 68	780 00	-855 57
Injurious insects, ...	38 57	-	200 00	161 43
Junior extension work, ...	3,640 42	40	3,160 00	-480 42
Lectures, ...	53 37	-	500 00	446 63
Library extension, ...	241 01	-	200 00	-41 01
Local community organization, . . .	558 87	14 40	1,000 00	441 13
Methods of extension instruction, . .	269 33	-	492 00	222 67
Plant diseases, ...	58 09	-	200 00	141 91
Pomology, ...	624 86	-	1,100 00	475 14
Poultry husbandry, ...	646 55	-	500 00	-146 55
Printing, ...	1,037 40	296 11	3,000 00	1,962 60
Rural civic planning, ...	14 64	16 90	-	-14 64
Salaries, ...	40,422 52	-	47,163 67	6,741 15
Sheep husbandry, ...	360 22	9 67	100 00	-260 22
Soils and crops, ...	932 44	-	940 00	7 56
State Treasurer, account of schedules, .	-	68,970 47	-	-
Income remitted to State Treasurer, .	1,185 13	-	-	-
	\$70,977 46	\$70,860 35	\$78,000 67	\$8,208 34
Less journal entries (\$704.75), refund (\$111.11) and \$6.	821 86	704 75	-	-
	\$70,155 60	\$70,155 60	-	-

¹ Includes Federal Smith-Lever Fund.

EXTENSION SERVICE — *Continued.**Summary.*

	Disbursements.	Receipts.
Balance Dec. 1, 1918, ...	—	\$2,618 11
Receipts Nov. 30, 1919, ...	—	1,185 13
Received from State Treasurer, ...	—	68,970 47
Received from United States Treasurer, ...	—	25,392 19
Disbursements to Nov. 30, 1919, ...	\$92,357 05	—
Receipts turned into State Treasurer, ...	1,185 13	—
	\$93,542 18	\$98,165 90
Bills receivable Dec. 1, 1918, deducted, ...	—	138 03
Bills payable Dec. 1, 1918, deducted, ...	69 25	—
	\$93,472 93	\$98,027 87
Bills receivable Nov. 30, 1919, ...	—	88 82
Bills payable Nov. 30, 1919, ...	708 11	—
Balance, ...	3,935 65	—
	\$98,116 69	\$98,116 69

SMITH-LEVER FUND (FEDERAL).

	Disbursements.	Receipts.
Administration, ...	\$5 00	-
Dairying, ...	161 96	\$250 00
Extension schools, ...	747 94	
District and county agents, ...	38 05	-
Farm management demonstration, ...	553 02	-
Home economics, ...	75 46	-
Home gardening, ...	37 23	-
Horticultural manufactures, ...	379 81	-
Junior extension, ...	1,939 90	-
Plant diseases, ...	239 68	-
Pomology, ...	17 08	-
Poultry husbandry, ...	539 30	-
Printing and publications, ...	515 71	-
Salaries, ...	17,734 01	-
Sheep husbandry, ...	402 43	-
State Treasurer, ...	-	25,142 19
	\$23,386 58	\$25,392 19
Balance beginning of fiscal year Dec. 1, 1918, ...	-	2,618 11
Balance on hand Nov. 30, 1919, ...	4,623 72	-
Totals, ...	\$28,010 30	\$28,010 30

SHORT COURSES.

	Salary.	Office.	Laboratory Supplies.	Labor.	Travel.	Miscellaneous.	Total.
Two-year course, ...	\$3,614 42	\$253 82	\$446 10	\$249 11	\$194 51	\$564 26	\$5,322 22
Ten weeks' winter course, ...	150 00	74 44	1,208 67	44 69	154 15	221 72	1,853 67
Summer school, ...	3,990 00	179 95	577 16	960 40	73 25	850 87	6,631 63
Administration, ...	3,225 00	3 50	-	-	45 93	312 08	3,536 51
Totals, ...	\$10,979 42	\$511 71	\$2,231 93	\$1,254 20	\$407 84	\$1,943 93	\$17,394 03
Less cash refunds, ...	-	-	-	-	-	-	28 00
	-	-	-	-	-	-	\$17,366 03
State appropriation, ...	-	-	\$17,000 00	-	-	-	-
Amount of receipts, ...	-	-	1,898 63	-	-	-	-
Amount of receipts transferred to State Treasurer, ...	-	\$1,898 63	-	-	-	-	-
Department expenditures, ...	-	17,366 03	-	-	-	-	-
Balance overdrawn, ...	-	-	366 03	-	-	-	-
	-	\$19,264 66	\$19,264 66	-	-	-	-

MARKET GARDEN FIELD STATION.

	Debit.	Credit.
Labor, ...	\$4,666 08	
Maintenance, ...	1,481 12	
Minor equipment, ...	221 48	
Miscellaneous, ...	18 07	
Total, ...	\$6,386 75	
Less journal entries, ...	34 80	
Net expenditures, ...	\$6,351 95	
State appropriation, ...		\$8,000 00
Amount of receipts, ...		2,795 98
Amount of receipts transferred to State Treasurer, ...	\$2,795 98	
Department expenditures, ...	6,351 95	
Balance unexpended, ...	1,648 05	
	\$10,795 98	\$10,795 98

SPECIAL APPROPRIATIONS.

	Date made.	Appropriation.	Amount expended to Date.	Unexpended Balance.
Agricultural building, ...	1914	\$210,000 00	\$210,000 00	-
Microbiology building, ...	1915	67,500 00	65,450 31	\$2,049 69
Agricultural building, ...	1916	13,732 34	12,243 49	1,488 85
Rural engineering building, ...	1916	12,000 00	11,997 57	2 43
Improvement and equipment, ...	1917	33,500 00	33,471 20	28 80
Power plant improvements, ...	1917	40,000 00	39,955 91	44 09
Printing, ...	1917	-	888 79	-
Improvement and equipment, ...	1918	20,000 00	19,496 57	503 43
Power plant improvements, ...	1918	54,500 00	54,500 00	-
Market garden field station, ...	1918	16,500 00	13,068 97	3,431 03
Dining hall, ...	1918	12,000 00	11,676 41	323 59
Printing, ...	1918	3,000 00	3,000 00	-
Improvement and equipment, ...	1919	20,000 00	10,443 74	9,556 26
Women's dormitory, ...	1919	127,400 00	6,016 07	121,383 93
Market garden field station, ...	1919	15,000 00	4,348 73	10,651 27
Engineering studies, ...	1919	2,000 00	832 27	1,167 73
Printing, ...	-	-	158 17	-
Feed law, ...	1919	6,000 00	6,000 00	-
Trustees' travel, ...	1919	900 00	1,027 48	-127 48
S. A. T. C., plumbing, ...	-	-	2,501 64	-
Totals, ...	-	\$654,032 34	\$507,077 32	\$150,503 62
Amount spent previous to Dec. 1, 1918, ...	-	-	-	395,119 37
Amount expended during fiscal year, ...	-	-	-	111,957 95
Unexpended balance Nov. 30, 1919, ...	-	-	150,503 62	-
	-	\$654,032 34	\$657,580 94	\$657,580 94

INVENTORY — REAL ESTATE.

Land (Estimated Value).

Angus land, ...	\$800 00
Allen place, ...	500 00
Baker place, ...	2,500 00
Bangs place, ...	2,350 00
Brown land, ...	500 00
Charmbury place, ...	450 00
Clark place, ...	4,500 00
College farm, ...	37,000 00
Cranberry land, ...	12,745 00
Geo. Cutler, Jr., trustee, ...	2,700 00
Dickinson land, ...	7,850 00
Harlow farm, ...	1,584 63
Hawley and Brown place, ...	675 00
Kellogg place, ...	3,368 45
Loomis place, ...	415 00
Louisa Baker place, ...	5,000 00
Market garden field station, ...	4,800 00
Mount Toby demonstration forest, ...	30,000 00
Newell farm, ...	2,800 00
Old creamery place, ...	1,000 00
Owen farm, ...	5,000 00
Pelham quarry, ...	500 00
Tillson farm, ...	2,950 00
Westcott place, ...	2,250 00
Total, ...	\$132,238 08

College Buildings (Estimated Value).

	Inventory at Beginning of Year.	Per Cent de- ducted.	Value at Beginning of Year less Per Cent De- terioration.	Repairs and Improve- ments during Year.	Total Value at Close of Fiscal Year.
Apiary, ...	\$3,043 03	2	\$2,982 17	\$10 85	\$2,993 02
Animal husbandry building, . .	9,390 57	2	9,202 76	8 60	9,211 36
Cashier's house, ...	1,660 90	5	1,577 85	25 75	1,603 60
Chemical laboratory, ...	8,190 95	5	7,781 40	552 44	8,333 84
Clark Hall, ...	63,995 60	2	62,715 69	353 03	63,068 72
Cold-storage laboratory, ...	11,190 07	2	10,966 27	7 50	10,973 77
Dairy building, ...	71,226 86	2	69,802 32	373 47	70,175 79
Dairy barn and storage, ...	27,599 63	3	26,771 64	146 43	26,918 07
Dining hall, ...	65,797 49	3	63,823 57	3,643 57	67,467 14
Drill hall and gun shed, ...	8,891 24	5	8,446 63	317 28	8,763 96
Durfee glass houses, old, ...	8,582 37	5	8,153 25	3 96	8,157 21
Durfee glass houses, new, ...	12,497 72	5	11,872 83	176 87	12,049 70
Entomology building, ...	74,801 30	2	73,305 27	333 83	73,639 10
Farm bungalow, ...	2,653 85	3	2,574 23	9 78	2,584 01
Farmhouse No. 1, ...	2,492 24	3	2,417 47	187 33	2,604 80
Farmhouse No. 2, ...	4,512 52	8	4,151 52	20 86	4,172 38
French Hall, ...	47,071 45	2	46,130 02	194 39	46,324 41
Grounds' tool shed, ...	245 00	5	232 75	-	232 75
Harlow house, ...	1,603 55	5	1,523 37	31 54	1,554 91
Horse barn, ...	4,649 75	3	4,510 26	24 78	4,535 04
Head of Division of Horticulture, .	2,342 52	5	2,225 39	27 64	2,253 03
Horticultural barn, ...	2,433 67	3	2,390 66	108 66	2,469 32
Horticultural tool shed, ...	1,770 59	3	1,717 47	-	1,717 47
Hospital, ...	14,917 49	2	14,519 14	98 32	14,617 46
Kellogg house, ...	2,369 50	5	2,251 02	317 67	2,568 69
Machinery barn, ...	3,565 35	3	3,458 39	12 66	3,471 05
Market garden field station barn, .	3,395 00	3	3,293 15	-	3,293 15
Mathematical building, ...	5,185 08	5	4,925 83	7 57	4,933 40
Microbiology building, ...	59,981 80	2	58,782 16	155 48	58,937 64
Military storage, ...	250 00	5	237 50	-	237 50
Mount Toby house and barn, . . .	4,007 18	5	3,806 82	2 85	3,809 67
North dormitory, ...	24,550 64	2	24,059 63	459 97	24,519 60
Physics laboratory, ...	4,673 48	5	4,439 81	353 59	4,793 40
Piggery, ...	2,672 97	3	2,592 78	-	2,592 78

College Buildings (Estimated Value) — Concluded.

	Inventory at Beginning of Year.	Per Cent de- ducted.	Value at Beginning of Year less Per Cent De- terioration.	Repairs and Improve- ments during Year.	Total Value at Close of Fiscal Year.
Poultry department:—					
No. 1 demonstration building, .	\$1,354 12	2	\$1,327 04	\$3 51	\$1,330 55
No. 2 oil house, ...	71 60	2	70 17	—	70 17
No. 3 brooder, killing and fattening laboratory.	2,389 09	2	2,332 49	—	2,332 49
No. 4 mechanics, storage building and incubator cellar.	3,445 07	2	3,376 17	12 37	3,388 54
No. 5 laying house, ...	1,663 43	2	1,630 16	10 28	1,640 44
No. 6 manure shed, ...	94 73	2	92 84	—	92 84
No. 7 small henhouse, ...	47 67	2	46 72	—	46 72
No. 8 breeding house, ...	1,504 66	2	1,474 57	5 20	1,479 77
No. 9 experimental breeding house, .	592 23	2	580 39	—	580 39
No. 10 duck house, ...	98 01	2	96 05	—	96 05
No. 11 unit house for 200 hens, .	495 85	2	485 93	—	485 93
No. 12 unit house for 100 hens, .	400 10	2	392 10	—	392 10
Power plant and storage building, in- cluding coal pocket.	47,410 53	2	46,462 32	1,734 38	48,196 70
President's house, ...	11,958 83	3	11,609 07	1,655 28	13,264 35
Quarantine barn, ...	486 91	3	472 30	—	472 30
Rural engineering building, . . .	3,585 03	2	3,513 33	2 18	3,515 51
Sheep barn, ...	1,457 31	3	1,413 59	—	1,413 59
South dormitory, ...	35,090 90	2	34,389 08	2,917 57	37,306 65
Stockbridge Hall, ...	175,342 74	2	171,835 89	343 59	172,179 48
Agronomy greenhouse, ...	2,039 09	2	1,998 31	1 18	1,999 49
Stockbridge house, ...	1,407 23	5	1,336 87	262 67	1,599 54
Stone chapel, ...	28,323 67	2	27,757 20	134 76	27,891 96
Turbine house, ...	—	—	—	—	17,665 00
Vegetable plant house, ...	4,366 24	5	4,147 93	222 36	4,370 29
Veterinary laboratory and stable, .	22,519 03	2	22,068 65	14 90	22,083 55
Waiting station, ...	476 30	2	466 77	—	466 77
Wilder Hall, ...	34,971 06	2	34,271 64	31 51	34,303 15
Young stock barn, ...	5,948 16	3	5,769 72	84 72	5,854 44
Totals, ...	\$949,741 95	—	\$927,028 37	\$15,403 13	\$960,096 50

College Equipment (Estimated Value).

Administrative division:—

Dean's office, ...	\$484 90
President's office, ...	2,188 00
Registrar's office, ...	1,206 11
Treasurer's office, ...	3,035 89

Agricultural division:—

Agronomy, ...	6,860 06
Animal husbandry, ...	729 38
Dairy, ...	20,077 28
Farm, ...	48,923 66
Farm management, ...	969 90
General agriculture, ...	3,879 95
Poultry, ...	6,441 91
Rural engineering, ...	3,897 21
Domestic science, ...	1,906 81
Dining hall, ...	17,868 48
Extension, ...	12,407 97

General science:—

Apiary, ...	2,218 06
Botanical, ...	23,023 76
Chemical, ...	12,853 42
Entomology, ...	4,612 52
Mathematics, ...	2,407 25
Microbiology, ...	7,792 05
Physics, ...	7,005 15
Veterinary, ...	10,260 25
Zoölogical and geological, ...	17,143 60
Graduate school, ...	115 80

Horticultural division:—

Floriculture, ...	18,897 04
Forestry, ...	2,180 74
General horticulture, ...	7,057 51
Grounds, ...	1,399 63
Horticultural manufactures, ...	4,117 40
Landscape gardening, ...	5,049 18
Market-garden field station, ...	1,711 90
Market gardening, ...	2,513 62
Mount Toby reservation, ...	4,905 29
Pomology, ...	5,929 30
Hospital, ...	1,104 72

Humanities division:—

Economics and sociology, ...	195 00
Language and literature, ...	626 00
Library, ...	107,724 13
Military, ...	1,417 05

Operating and maintenance:—

College supply, ...	1,650 30
Fire apparatus, ...	2,156 32
General maintenance, ...	172,769 99
Carpentry and masonry supplies, ...	6,252 49
Electrical supplies, ...	2,417 83
Equipment, ...	152,516 53
Heating and plumbing supplies, ...	9,844 07
Painting supplies, ...	1,739 07

*College Equipment (Estimated Value) — Concluded.*Operating and maintenance — *Con.*

Janitor's supplies, ...	\$863 33
Sewer line, ...	11,812 74
Water mains, ...	10,570 89
Physical education, ...	1,779 34
Rural social science:—	
Agricultural economics, ...	1,119 30
Agricultural education, ...	988 25
Rural sociology, ...	236 10
Short course, ...	536 80
Textbooks, ...	1,931 68
Trophy room, ...	1,200 00
Total, ...	\$590,752 92

Experiment Station Buildings (Estimated Value).

	Inventory at Beginning of Year.	Per Cent.	Cost at Beginning of Year less Per Cent De- terioration.	Repairs and Improve- ments during Year.	Total Value at Close of Year.
Agricultural laboratory, ...	\$14,483 32	2	\$14,193 65	\$31 13	\$14,224 78
Agricultural barn, ...	4,585 23	3	4,447 67	93	4,448 60
Agricultural farmhouse, ...	1,434 52	3	1,391 48	25 93	1,417 41
Agricultural glass house, ...	407 26	5	386 90	—	386 90
Cranberry buildings, ...	2,718 51	5	2,582 53	830 33	3,412 96
Plant and animal chemistry laboratory, ...	28,207 26	2	27,643 11	433 39	28,079 50
Plant and animal chemistry barns, ...	4,052 26	3	3,930 69	150 55	4,081 24
Plant and animal chemistry dairy, ...	1,770 59	3	1,717 47	—	1,717 47
Six poultry houses, ...	574 01	2	562 53	—	562 53
Entomological glass houses, ...	756 04	5	718 24	—	718 24
Tillson house, ...	570 93	5	542 38	16 02	558 40
Tillson barn, ...	1,140 00	5	1,083 00	—	1,083 00
Total, ...	\$60,699 93	—	\$50,199 70	\$1,491 33	\$60,691 03

Experiment Station Equipment (Estimated Value).

Apiary, ...	\$161 07
Agricultural economics department, ...	171 02
Agricultural laboratory, ...	7,563 90
Botanical laboratory, ...	6,692 98
Chemical laboratory, ...	24,317 12
Cranberry station, ...	3,632 40
Director's office, ...	5,940 16
Entomological laboratory, ...	23,598 84
Horticultural laboratory, ...	4,494 15
Meteorological laboratory, ...	758 00
Microbiological laboratory, ...	2,235 80
Poultry department, ...	5,338 33
Treasurer's office, ...	988 00
Total, ...	\$85,891 77

Inventory Summary.

Land, ...	\$132,238 08
College buildings, ...	960,096 50
College equipment, ...	590,752 92
Experiment Station buildings, ...	60,691 03
Experiment Station equipment, ...	85,891 77
Total, ...	\$1,829,670 30

	Acres.
College estate, area, ...	642.79
Cranberry station, Wareham, area, ...	23.67
Market-garden field station, Lexington, area, ...	12.00
Mount Toby demonstration forest, area, ...	755.27
Rifle range, ...	46.20
Pelham quarry, ...	.50
Total acreage, ...	1,480.43

STUDENTS' TRUST FUND ACCOUNT.

	Disburse- ments, Year ending Nov. 30, 1919.	Receipts, Year ending Nov. 30, 1919.	Balance on Hand.	Balance brought for- ward Dec. 1, 1918.
Athletics, ...	\$11,232 22	\$9,918 44	—\$1,140 94	\$172 84
Dining hall, ...	63,848 95	76,299 55	—11,230 05	—23,680 65
Keys, ...	64 50	123 25	77 00	18 25
Student deposits, ...	37,679 25	44,967 24	17,856 64	10,568 65
Social Union, ...	970 57	1,471 58	817 93	316 92
Textbooks, ...	7,253 02	6,929 88	674 63	998 67
Athletic field, ...	723 82	822 27	—256 26	—354 71
Uniforms, ...	17 06	27 56	31 54	21 04
Fertilizer law, ...	11,660 23	11,660 23	—	—
Cow testing, ...	14,278 94	14,617 69	338 75	—
Dairy law, ...	616 69	593 02	—23 67	—
	\$148,346 15	\$167,430 71	\$7,145 57	—\$11,933 99
	—11,933 99	—	—	—
	7,145 57	—	—	—
	\$167,430 71	\$167,430 71	—	—

CONDENSED OPERATING STATEMENT OF THE DINING HALL.

	Operating Charges.	Income.
1918.		
Dec. 1, Balance, ...	\$23,680 65	-
1919.		
Nov. 30, Total disbursements, ...	63,848 95	-
Outstanding bills, ...	3,254 89	-
Total collections, ...	-	\$76,299 55
Accounts outstanding, ...	-	596 49
Inventory, ...	-	9,868 68
Balance, ...	-	4,019 77
	\$90,784 49	\$90,784 49

ENDOWMENT FUND.¹

	Principal.	Income.
United States grant (5 per cent), ...	\$219,000 00	\$7,300 00
Commonwealth grant (3½ per cent), ...	142,000 00	3,313 32
	-	\$10,613 32

¹ This fund is in the hands of the State Treasurer, and the Massachusetts Agricultural College received two-thirds of the income from the same.

BURNHAM EMERGENCY FUND.

	Market Value Dec. 1, 1919.	Par Value.	Income.
Two bonds American Telephone and Telegraph Company 4s, at \$310, ...	\$1,620 00	\$2,000 00	\$80 00
Two bonds Western Electric Company 5s, at \$970, ...	1,940 00	2,000 00	100 00
One United States Liberty Bond 4s, at \$940, ...	470 00	500 00	20 00
	\$4,030 00	\$4,500 00	\$200 00
Unexpended balance Dec. 1, 1918, ...	—	—	380 55
Cash on hand Nov. 30, 1919, ...	—	—	\$580 55

LIBRARY FUND.

Five bonds New York Central & Hudson River Railroad Company 4s, at \$850, ...	\$4,250 00	\$5,000 00	\$200 00
Five bonds Lake Shore & Michigan Southern Railroad Company 4s, at \$880, ...	4,400 00	5,000 00	200 00
Two shares New York Central & Hudson River Railroad Company stock, at \$70, ...	140 00	200 00	10 00
Amherst Savings Bank, deposit, ...	167 77	167 77	7 59
	\$8,957 77	\$10,367 77	\$417 59
Disbursements for fiscal year ending Nov. 30, 1919, . . .	—	—	417 59

SPECIAL FUNDS.

Endowed Labor Fund (the Gift of a Friend of the College).

Two bonds American Telephone and Telegraph Company 4s, at \$310, ...	\$1,620 00	\$2,000 00	\$80 00
Two bonds Lake Shore & Michigan Southern Railroad Company 4s, at \$880, ...	1,760 00	2,000 00	80 00
One bond New York Central Railroad debenture 4s, ...	850 00	1,000 00	40 00
One bond Louisville Gas and Electric 7s, ...	1,000 00	1,000 00	69 61
Amherst Savings Bank, deposit, ...	143 39	143 39	6 49
One United States Liberty Bond 4½s, ...	940 00	1,000 00	41 45
	\$6,313 39	\$7,143 39	\$317 55
Unexpended balance Dec. 1, 1918, ...	—	—	76 20
Cash on hand Nov. 30, 1919, ...	—	—	\$393 75

Whiting Street Scholarship Fund.

One bond New York Central debenture 4s, ...	\$850 00	\$1,000 00	\$40 00
Amherst Savings Bank, deposit, ...	271 64	271 64	12 32
	\$1,121 64	\$1,271 64	\$52 32
Unexpended balance Dec. 1, 1918, ...	—	—	342 87
Cash on hand Nov. 30, 1919, ...	—	—	\$395 19

SPECIAL FUNDS — *Continued.**Hills Fund.*

	Market Value Dec. 1, 1919.	Par Value.	Income.
One United States Liberty Bond 4s, at	\$940 00	\$1,000 00	\$40 00
One United States Liberty Bond 4½s, at	940 00	1,000 00	41 45
One bond American Telephone and Telegraph Company 4s, at	810 00	1,000 00	40 00
One bond New York Central & Hudson River Railroad debenture 4s, at	850 00	1,000 00	40 00
One bond New York Central Railroad debenture 4s, at	850 00	1,000 00	40 00
Three bonds Pacific Telephone and Telegraph Company 5s, at \$880, ...	2,640 00	3,000 00	150 00
One bond Western Electric Company 5s, at	970 00	1,000 00	50 00
Boston & Albany Railroad Stock, 3¼ shares at \$125, ...	453 00	362 00	31 68
Amherst Savings Bank, deposit, ...	72 75	72 75	3 28
Electric Securities Company bonds 1½% bonds at \$950, ...	1,121 00	1,180 00	59 00
Two bonds Louisville Gas and Electric 7s, at	2,000 00	2,000 00	139 22
	\$11,646 75	\$12,614 75	\$634 63
Unexpended balance Dec. 1, 1918, ...	—	—	295 33
	—	—	\$929 96
Disbursements for fiscal year ending Nov. 30, 1919, ...	—	—	15 00
Cash on hand Nov. 30, 1919, ...	—	—	\$914 96

Mary Robinson Fund.

Amherst Savings Bank, deposit, ...	\$142 00	\$142 00	\$6 45
Boston & Albany Railroad stock, ¾ share at \$125, ...	47 00	38 00	3 32
Electric Securities Company Bonds, 1½% bond, at \$950, ...	779 00	820 00	41 00
	\$968 00	\$1,000 00	\$50 77
Unexpended balance Dec. 1, 1918, ...	—	—	239 73
Cash on hand Nov. 30, 1919, ...	—	—	\$290 50

Grinnell Prize Fund.

Ten shares New York Central & Hudson River Railroad stock, at \$70, ...	\$700 00	\$1,000 00	\$50 00
Unexpended balance Dec. 1, 1918, ...	—	—	245 74
	\$700 00	\$1,000 00	\$295 74
Disbursements for prizes, ...	—	—	50 00
Cash on hand Nov. 30, 1919, ...	—	—	\$245 74

Gassett Scholarship Fund.

One bond New York Central & Hudson River Railroad debenture 4s, at \$850, ...	\$850 00	\$1,000 00	\$40 00
Amherst Savings Bank, deposit, ...	11 64	11 64	48
	\$861 64	\$1,011 64	\$40 48
Unexpended balance Dec. 1, 1918, ...	—	—	263 71
Cash on hand Nov. 30, 1919, ...	—	—	\$304 19

SPECIAL FUNDS — *Continued.**Massachusetts Agricultural College (Investment).*

	Market Value Dec. 1, 1919.	Par Value.	Income.
One share New York Central & Hudson River Railroad Stock at \$70, ...	\$70 00	\$100 00	\$5 00
Unexpended balance Dec. 1, 1918, ...	—	—	90 45
Cash on hand Nov. 30, 1919, ...	—	—	\$95 45

Danforth Keyes Bangs Fund.

Two bonds Pacific Telephone and Telegraph Company 5s, at \$880, ...	\$1,760 00	\$2,000 00	\$100 00
Two bonds Union Electric Light and Power Company 5s, at \$920, ...	1,840 00	2,000 00	100 00
Two bonds American Telephone and Telegraph Company 4s, at \$810, ...	1,620 00	2,000 00	80 00
Interest from student loans, ...	—	—	43 09
One United States Liberty Bond 4½s, at	940 00	1,000 00	41 45
Unexpended balance Dec. 1, 1918, ...	\$6,160 00	\$7,000 00	\$364 54
	—	—	1,023 24
	—	—	\$1,387 78
Total loans made to students during fiscal year, \$1,915 00			
Cash received on account of student loans, . . 1,105 00			
Excess of loans made over accounts paid by students, .	—	—	810 00
Cash on hand Nov. 30, 1919, ...	—	—	\$577 78

John C. Cutter Fund.

One bond Pacific Telephone and Telegraph Company 5s, at	\$880 00	\$1,000 00	\$50 00
Unexpended balance Dec. 1, 1918, ...	—	—	126 13
	\$880 00	\$1,000 00	\$176 13
Disbursements for fiscal year to date, ...	—	—	14 63
Cash on hand Nov. 30, 1919, ...	—	—	\$161 50

William R. Sessions Fund.

One \$500 bond New York Central & Hudson River Rail- road Stock 6s, at \$910, ...	\$455 00	\$500 00	\$30 00
Three United States Liberty Bonds, two at \$1,000 and one at \$500, 4s, at \$940, ...	2,350 00	2,500 00	100 00
One bond Toledo Light and Power Company 7s, at	1,000 00	1,000 00	70 00
One bond United Electric Light Company 6s, at	1,000 00	1,000 00	60 00
Unexpended balance Dec. 1, 1918, ...	\$4,805 00	\$5,000 00	\$260 00
	—	—	378 11
	—	—	\$638 11
Disbursements for fiscal year ending Nov. 30, 1919, ...	—	—	587 53
Cash on hand Nov. 30, 1919, ...	—	—	\$50 58

SPECIAL FUNDS — *Concluded.**Alvord Dairy Scholarship Fund.*

	Market Value Dec. 1, 1919.	Par Value.	Income.
One United States Liberty Bond 4s, at	\$940 00	\$1,000 00	\$40 00
One bond Toledo Light and Power Company 7s, at	1,000 00	1,000 00	70 00
Two bonds United Electric Light Company 6s, at	2,000 00	2,000 00	120 00
	\$3,940 00	\$4,000 00	\$230 00
Overdraft Dec. 1, 1918, ...	—	—	14 70
Cash on hand Nov. 30, 1919, ...	—	—	\$215 30

SUMMARY OF BALANCES ON HAND OF THE INCOME FROM FUNDS HELD IN
TRUST BY THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Burnham emergency fund, ...	\$580 55
Endowed labor fund, ...	393 75
Whiting Street scholarship fund, ...	395 19
Hills fund, ...	914 96
Mary Robinson fund, ...	290 50
Grinnell prize fund, ...	245 74
Gassett scholarship fund, ...	304 19
Massachusetts Agricultural College investment fund, ...	95 45
Danforth Keyes Bangs fund, ...	577 73
John C. Cutter fund, ...	161 50
William R. Sessions fund, ...	50 58
Alvord dairy scholarship fund, ...	215 30
	\$4,225 49
W. D. Cows and J. H. Howard, land, ...	\$733 33
March 26, by check, ...	366 67
	366 66
	\$3,858 83

I hereby certify that I have this day examined the Massachusetts Agricultural College account, as reported by the Treasurer, Fred C. Kenney, for the year ending Nov. 30, 1919. All bonds and investments are as represented in the treasurer's report. All disbursements are properly vouched for, and all cash balances are found to be correct.

CHARLES A. GLEASON,
Auditor.

AMHERST, Jan. 8, 1920.

HISTORY OF SPECIAL FUNDS.

Burnham emergency fund:—

A bequest of \$5,000 from T. O. H. P. Burnham of Boston made without any conditions. The trustees of the college directed that \$1,000 of this fund should be used in the purchase of the Newell land and Goessmann library.

The fund now shows an investment of \$4,000 00

Library fund:—

The library of the college at the present time contains 61,439 volumes. The income from the fund raised by the alumni and others is devoted to its increase, and additions are made from time to time as the needs of the different departments require. Dec. 27, 1883, William Knowlton gave \$2,000; Jan. 1, 1894, Charles L. Flint gave \$1,000; in 1887, Elizur Smith of Lee, Mass., gave \$1,315. These were the largest bequests, and now amount to

10,000 00

Endowed labor fund:—

Gift of a friend of the college in 1901, income of which is to be used for the assistance of needy and deserving students, ...

5,000 00

Whiting Street scholarship fund:—

Gift of Whiting Street of Northampton, for no special purpose, but to be invested and the income used. This fund is now used exclusively for scholarship, ...

1,000 00

Hills fund:—

Gift of Leonard M. and Henry F. Hills of Amherst, Mass., in 1867, to establish and maintain a botanic garden, ...

10,000 00

Mary Robinson fund:—

Gift of Miss Mary Robinson of Medfield, in 1874, for scholarship, ...

1,000 00

Grinnell prize fund:—

Gift of Hon. Wm. Claflin, to be known as the Grinnell agricultural prize, to be given to the two members of the graduating class who may pass the best oral and written examination in theory and practice of agriculture, given in honor of George B. Grinnell of New York, ...

1,000 00

Gassett scholarship fund:—

Gift of Henry Gassett of Boston, the income to be used for scholarship, ...

1,000 00

Massachusetts Agricultural College investment fund:—

Investment made by vote of trustees in 1893 to purchase one share of New York Central & Hudson River Railroad stock. The income from this fund has been allowed to accumulate, ...

100 00

Danforth Keyes Bangs fund: —

Gift of Louisa A. Baker of Amherst, Mass., April 14, 1909,
the income thereof to be used annually in aiding poor,
industrious and deserving students to obtain an education
in said college, ... \$6,000 00

John C. Cutter fund: —

Gift of Dr. John C. Cutter of Worcester, Mass., an alumnus
of the college, who died in August, 1909, to be invested
by the trustees, and the income to be annually used for
the purchase of books on hygiene, ... 1,000 00

Alvord dairy scholarship fund: —

Gift of Henry E. Alvord, who was the first instructor in
military tactics, 1869-71, and a professor of agriculture,
1885-87, at this institution. The income of this fund is
to be applied to the support of any worthy student of said
college, graduate or postgraduate, who may be making
a specialty of the study of dairy husbandry (broadly
considered), with the intention of becoming an investi-
gator, teacher or special practitioner in connection with
the dairy industry, provided that no benefits arising
from such fund shall at any time be applied to any person
who then uses tobacco in any form, or fermented or
spirituous beverages, or is known to have done so within
one year next preceding, ... 4,000 00

William R. Sessions fund: —

In accordance with the request of my deceased wife, Clara
Markham Sessions, made in her last will, I bequeath to
the trustees of the Massachusetts Agricultural College,
Amherst, Mass., the sum of \$5,000, it being the amount
received by me from the estate of the said Clara Mark-
ham Sessions. The said \$5,000 to be kept by the said
trustees a perpetual fund, the income from which shall
be for the use of the Massachusetts Agricultural College;
and according to the further request of my deceased wife,
made in her last will, this is to be known as the William R.
Sessions fund, and is to be a memorial of William R. Ses-
sions; and it is my special request that the said trustees
shall make record of the fact that this fund came from the
estate of my deceased wife, Clara Markham Sessions, in
accordance with her request made in her last will, . . . 5,000 00

\$49,100 00

FRED C. KENNEY,

Treasurer.

PUBLIC DOCUMENT

No. 31

MASSACHUSETTS
AGRICULTURAL COLLEGE

CATALOGUE, 1919-1920



THE M. A. C. BULLETIN AMHERST, MASSACHUSETTS

VOLUME XII JANUARY, 1920 NUMBER I

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THE FIFTY-SEVENTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

PART II.—CATALOGUE OF THE COLLEGE FOR 1919-1920



PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

The Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Nov. 29, 1919.

To His Excellency CALVIN COOLIDGE.

SIR: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith, to Your Excellency and the Honorable Council, Part II of the fifty-seventh annual report of the trustees, this being the catalogue of the college.

I am, very respectfully, your obedient servant,

KENYON L. BUTTERFIELD,
President.

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THE MASSACHUSETTS
AGRICULTURAL COLLEGE

Without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and mechanic arts in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. — *Act of Congress, July 2, 1862.*

This issue of the catalogue represents the status of the college for the current college year, with provisional announcement of courses of study and other matters for the year to follow. When deemed necessary, additional announcements are made in a supplementary bulletin, published in the spring.

The college reserves, for itself and its departments, the right to withdraw or change the announcements made in its catalogue. Special publication will be made should it become necessary on account of important changes.

CALENDAR.

1919-20-21.

REGULAR AND TWO-YEARS' COURSES.

1919.

September 24, Wednesday, 1.30 P.M., ...	Fall term begins; assembly.
October 13, Monday, ...	Holiday — Columbus Day.
November 11, Tuesday, ...	Holiday — Armistice Day.
November 26-28, Wednesday, 12 M.-Friday, 1 P.M., ...	Thanksgiving recess.
December 19, Friday, 5 P.M., ...	Fall term closes.
December 30, Tuesday, 7.30 A M., ...	Winter term begins.

1920.

February 23, Monday, ...	Holiday — Washington's Birthday.
March 19, Friday, 5 P.M., ...	Winter term closes.
March 29, Monday, 1 P.M., ...	Spring term begins.
April 19, Monday, ...	Holiday — Patriots' Day.
May 31, Monday, ...	Holiday — Memorial Day.
June 19-22, Saturday-Tuesday, ...	Commencement.
June 24-26, Wednesday-Saturday, ...	Entrance examinations.
September 22-25, Wednesday-Saturday, ...	Entrance examinations.
September 29, Wednesday, 1.30 P.M., ...	Fall term begins; assembly.
October 12, Tuesday, ...	Holiday — Columbus Day.
November 24-26, Wednesday, 12 M.-Friday, 1 P.M., ...	Thanksgiving recess.
December 23, Thursday, 5 P.M., ...	Fall term ends.

1921.

January 3, Monday, 1 P.M., ...	Winter term begins.
February 22, Tuesday, ...	Holiday — Washington's Birthday.
March 25, Friday, 5 P.M., ...	Winter term ends.
April 4, Monday, 1 P.M., ...	Spring term begins.
April 19, Tuesday, ...	Holiday — Patriots' Day.
May 30, Monday, ...	Holiday — Memorial Day.
June 25-28, Saturday-Tuesday, ...	Commencement.
June 30-July 2, Thursday-Saturday, ...	Entrance examinations.
September 21-24, Wednesday-Saturday, ...	Entrance examinations.
September 28, Wednesday, 1.30 P.M., ...	Fall term begins; assembly.

MASSACHUSETTS AGRICULTURAL COLLEGE.

HISTORY. — The Massachusetts Agricultural College was organized under the national land grant act of 1862. This legislation is also known as the Morrill act, the original bill having been framed by Justin Smith Morrill, Senator from Vermont, and its final enactment secured under his leadership. It provided that public lands be assigned to the several States and territories, the funds from the sale of which were to be used to establish and maintain colleges of agriculture and mechanic arts. The Massachusetts Agricultural College is among the first of these institutions established. When this act was passed the Massachusetts Institute of Technology was already organized, and the State of Massachusetts definitely decided that the instruction in the mechanic arts should be at the institute, and that the new institution should confine its work to agriculture. On this account the Massachusetts Agricultural College has the unique distinction of being the only separate agricultural college in the country.

In 1863 the State of Massachusetts accepted the provisions of the Morrill act and incorporated the Agricultural College. The location at Amherst was decided only after long and careful study by the original Board of Trustees. The college was formally opened to students on the 2d of October, 1867, with a faculty of four teachers and with four wooden buildings.

The Massachusetts Legislature has granted money for the erection of practically all of the buildings now on the grounds. In view of the fact that the annual income from the original endowment has been only a few thousand dollars, it has been necessary for the State to assume responsibility for the current expenses of the institution.

ORGANIZATION. — The college is a State institution, and as such is subject to the laws governing and the rules applying to all State departments and institutions. The work of the college is directed by a board of eighteen trustees. Four of these are ex-officio members, — the Governor of the State, the Commissioner of Education, the Commissioner of Agriculture and the president of the college. The other fourteen members are appointed by the Governor for terms of seven years each, or two each year. The immediate control of the institution is vested in the president of the college. The various administrative officers, having supervision of the various departments of activity, are directly responsible to the president.

In carrying out its purpose the college has organized three distinct yet correlated types of work, — namely, research, resident instruction and extension service.

RESEARCH. — Massachusetts provided for the establishment of an agricultural experiment station in 1882. This station, though on the college grounds and supported by the State, was without organic connection with the college. Under an act of Congress, passed in 1887, an agricultural experiment station was established and supported as a department of the college.

For a time, therefore, Massachusetts had two experiment stations at the college. In 1894 these were combined, and the station reorganized as a department of the college. It is now supported by funds from both the State and the Federal government. In 1906 the Federal government largely increased its support on condition that the money thus provided should be used only for research. The station now receives about two-thirds of its support from the State.

The station is under the direct supervision of the Board of Trustees; the chief officer is the director, who is responsible to the president. It is organized into a number of departments, all co-operating toward the betterment of agriculture. In most cases the heads of these departments are heads of corresponding departments in the college. The station publishes numerous bulletins and two annual reports, one scientific, the other popular. These publications are free and circulate extensively, the mailing list containing approximately 20,000 addresses.

RESIDENT INSTRUCTION. — The college offers an education without tuition fee to any student who is a resident of Massachusetts and who meets the requirements for admission. Women are admitted on the same basis as are men. Students who are not residents of Massachusetts are required to pay a nominal tuition fee. The chief aim of the institution, through its resident instruction, is to prepare men and women for the agricultural vocations. The term "agricultural vocations" is here used in its broadest sense. Courses are offered which give efficient training in various agricultural pursuits, such as general farming, dairying, management of estates, poultry husbandry, fruit growing, market gardening, floriculture, landscape gardening and forestry. Students are also trained for investigation in many sciences underlying the great agricultural industry, for teaching in agricultural colleges and high schools, and for scientific work in chemistry, entomology, botany and microbiology.

Though training for the agricultural vocations is thus the chief concern of the college, students should find the course one that trains them admirably for pursuits in which the sciences are an essential preparation. The course of study aims also to combine an adequate general education with specialized technical and practical training.

FOUR-YEAR COURSES. — Twenty-nine teaching departments offer instruction in agriculture, horticulture, sciences, the humanities, rural social science and rural home making. A system of major courses permits the student to elect major work in one of eighteen departments, and to specialize in it and allied subjects for a period of two years. The degree of bachelor of science is granted on the satisfactory completion of the four years' work of collegiate grade.

SHORT COURSES. — In order to extend the advantages of the institution to those men and women who cannot or do not care to take advantage of the four-year course, various short courses are offered. Chief among these are a two-year course in practical agriculture, a summer school of agriculture and country life, and a winter school of agriculture.

GRADUATE SCHOOL. — The graduate school is organized to provide the necessary training for scientific leadership in agriculture and allied sciences. The degrees of master of agriculture, master of landscape architecture, master of science, doctor of agriculture and doctor of philosophy may be earned upon the completion of satisfactory study, research and thesis.

THE EXTENSION SERVICE. — The extension service is an organized effort to carry systematic and dignified instruction to the thousands of people throughout the State who are unable, for various reasons, to take advantage of the regular courses offered at the college. It is in reality the "carrying of the college to the people of the State." Every department of the institution, insofar as the regular teaching and research work will permit, contributes what it can to this work. There is also a regular staff of extension workers whose sole business it is to present the instruction of the college to individuals and various organizations throughout the State, such as extension schools, granges and boards of trade.

LOCATION AND EQUIPMENT. — The Agricultural College is located in the town of Amherst. The grounds comprise more than 600 acres, lying about a mile north of the village center. The college has also a demonstration forest of 755 acres, located 6 miles north of the campus. The equipment of the college, both in buildings and facilities for instruction, is excellent. Amherst is 97 miles from Boston, and may be reached by the Central Massachusetts division of the Boston & Maine Railroad, or by the Central Vermont Railroad. Electric car lines connect Amherst with Northampton, Holyoke and Springfield.

MILITARY DRILL. — By Federal law military drill is required of all regular students attending the Massachusetts Agricultural College.

THE CORPORATION.

ORGANIZATION OF 1920.

MEMBERS OF THE CORPORATION.

	TERM EXPIRES
ELMER D. HOWE of Marlborough, ...	1921
EDMUND MORTIMER of Grafton, ...	1921
NATHANIEL I. BOWDITCH of Framingham, ...	1922
WILLIAM WHEELER of Concord, ...	1922
CHARLES A. GLEASON of New Braintree, ...	1923
JAMES F. BACON of Boston, ...	1923
FRANK GERRETT of Greenfield, ...	1924
HAROLD L. FROST of Arlington, ...	1924
CHARLES H. PRESTON of Danvers, ...	1925
CARLTON D. RICHARDSON of West Brookfield, ...	1925
DAVIS R. DEWEY of Cambridge, ...	1926
JOHN F. GANNON of Pittsfield, ...	1926
ARTHUR G. POLLARD of Lowell, ...	1927
GEORGE H. ELLIS of West Newton, ...	1927

MEMBERS EX OFFICIO.

His Excellency Governor CALVIN COOLIDGE, *President of the Corporation.*
 KENYON L. BUTTERFIELD, *President of the College.*
 PAYSON SMITH, *State Commissioner of Education.*
 ARTHUR W. GILBERT, *State Commissioner of Agriculture.*

OFFICERS OF THE CORPORATION.

His Excellency Governor CALVIN COOLIDGE of Northampton, *President.*
 CHARLES A. GLEASON of New Braintree, *Vice-President.*
 RALPH J. WATTS of Amherst, *Secretary.*
 FRED C. KENNEY of Amherst, *Treasurer.*
 CHARLES A. GLEASON of New Braintree, *Auditor.*

STANDING COMMITTEES OF THE CORPORATION.¹

Committee on Finance.

CHARLES A. GLEASON, *Chairman.*
 GEORGE H. ELLIS.
 NATHANIEL I. BOWDITCH.

ARTHUR G. POLLARD.
 CARLTON D. RICHARDSON.
 EDMUND MORTIMER.

Committee on Course of Study and Faculty.

WILLIAM WHEELER, *Chairman.*
 ELMER D. HOWE.
 PAYSON SMITH.

DAVIS R. DEWEY.
 JOHN F. GANNON.
 JAMES F. BACON.

Committee on Farm.

NATHANIEL I. BOWDITCH, *Chairman.*
 FRANK GERRETT.
 CARLTON D. RICHARDSON.

GEORGE H. ELLIS.
 EDMUND MORTIMER.
 ARTHUR W. GILBERT.

¹ The president of the college is ex-officio member of each committee.

Committee on Horticulture.

HAROLD L. FROST, *Chairman*.
CHARLES A. GLEASON.
EDMUND MORTIMER.

ELMER D. HOWE.
ARTHUR W. GILBERT.
CHARLES H. PRESTON.

Committee on Experiment Department.

CHARLES H. PRESTON, *Chairman*.
ARTHUR W. GILBERT.

ARTHUR G. POLLARD.
HAROLD L. FROST.

EDMUND MORTIMER.

Committee on Buildings and Arrangement of Grounds.

FRANK GERRETT, *Chairman*.
WILLIAM WHEELER.

CHARLES H. PRESTON.
GEORGE H. ELLIS.

JAMES F. BACON.

Committee on Extension Service.

ELMER D. HOWE, *Chairman*.
GEORGE H. ELLIS.
HAROLD L. FROST.

DAVIS R. DEWEY.
NATHANIEL I. BOWDITCH.
JOHN F. GANNON.

ARTHUR W. GILBERT.

OFFICERS OF THE INSTITUTION.

AS OF DEC. 1, 1919.

OFFICERS OF GENERAL ADMINISTRATION.

KENYON L. BUTTERFIELD, A.M., LL.D., ...	President's House.
President of the College.	
CHARLES H. FERNALD, Ph.D., ...	3 Hallock Street.
Honorary Director of the Graduate School.	
CHARLES R. GREEN, B.Agr., ...	Mount Pleasant.
Librarian.	
PHILIP B. HASBROUCK, B.Sc., ...	31 Fearing Street.
Registrar.	
FRED C. KENNEY, ...	Mount Pleasant.
Treasurer of the College.	
EDWARD M. LEWIS, A.M., ...	19 Lincoln Avenue.
Dean of the College.	
CHARLES E. MARSHALL, Ph.D., ...	44 Sunset Avenue.
Director of the Graduate School.	
FRED W. MORSE, M.Sc., ...	40 Pleasant Street.
Acting Director of the Experiment Station.	
JOHN PHELAN, A.M., ...	5 Mount Pleasant.
Director of Short Courses.	
RALPH W. REDMAN, B.Sc., ...	1 Mount Pleasant Avenue.
Acting Director of the Extension Service.	
RALPH J. WATTS, B.Sc., ...	101 Butterfield Terrace.
Secretary of the College.	
JOHN D. WILLARD, B.A., ¹	East Pleasant Street.
Director of the Extension Service.	

THE FACULTY OF INSTRUCTION.

KENYON L. BUTTERFIELD, A.M., LL.D., ...	President's House.
President of the College and Head of Division of Rural Social Science.	
CHARLES H. ABBOTT, Ph.D., ...	3 Dana Street.
Instructor in Zoölogy.	
MAX F. ABELL, B.Sc., ¹	103 Butterfield Terrace.
Assistant Professor of Farm Management.	
PAUL J. ANDERSON, Ph.D., ...	McClure Street.
Associate Professor of Botany.	
EDGAR L. ASHLEY, A.M., ...	24 Pleasant Street.
Associate Professor of German.	
LUTHER BANTA, B.Sc., ...	Lincoln Avenue.
Instructor in Poultry Husbandry.	
ARTHUR B. BEAUMONT, Ph.D., ...	5 Farview Way.
Professor of Agronomy and Head of Department.	
HENRY J. BURT, B.Sc., ...	Physics Building.
Assistant in Physics.	
ALEXANDER E. CANCE, Ph.D., ...	9 Fearing Street.
Professor of Agricultural Economics and Head of Department.	

¹ Appointment to take effect Jan. 1, 1920.

JOSEPH S. CHAMBERLAIN, Ph.D.,	Mount Pleasant.
Professor of Organic and Agricultural Chemistry.	
WALTER W. CHENOWETH, M.Sc.,	North Amherst.
Professor of Horticultural Manufactures and Head of Department.	
ORTON L. CLARK, B.Sc.,	16 College Street.
Assistant Professor of Botany.	
WILLIAM D. CLARK, A.B., M.F.,	45 Amity Street.
Professor of Forestry and Head of Department.	
HERBERT P. COOPER, M.Sc.,	24 Pleasant Street.
Assistant Professor of Agronomy.	
GUY C. CRAMPTON, Ph.D.,	116 Pleasant Street.
Professor of Insect Morphology.	
ARTHUR L. DACY, B.Sc.,	2 Allen Street.
Associate Professor of Vegetable Gardening.	
A. LAWRENCE DEAN,	24 Pleasant Street.
Instructor in Poultry Husbandry.	
BROOKS D. DRAIN, B.Sc.,	24 Pleasant Street.
Assistant Professor of Pomology.	
HENRY T. FERNALD, Ph.D.,	44 Amity Street.
Professor of Entomology, Head of Department, Chairman of Division of Science.	
JAMES A. FOORD, M.S.A.,	54 Lincoln Avenue.
Professor of Farm Management, Head of Department, Head of Division of Agriculture.	
GEORGE E. GAGE, A.B., M.A., Ph.D.,	2 Farview Way.
Associate Professor of Animal Pathology.	
HELENA T. GOESSMANN, M.Ph.,	21 Pleasant Street.
Instructor in English.	
CLARENCE E. GORDON, Ph.D.,	38 Lincoln Avenue.
Professor of Zoölogy and Geology and Head of Department.	
HAROLD M. GORE, B.Sc.,	The Davenport.
Assistant Professor of Physical Education.	
CHARLES H. GOULD, B.Sc.,	12 Chestnut Street.
Instructor in Pomology.	
JOHN C. GRAHAM, B.Sc., ¹	Lincoln Avenue.
Professor of Poultry Husbandry and Head of Department.	
EMORY E. GRAYSON, B.Sc.,	120 Pleasant Street.
Instructor in Physical Education.	
CHRISTIAN I. GUNNESS, B.Sc.,	105 Butterfield Terrace.
Professor of Rural Engineering and Head of Department.	
MARGARET HAMLIN, B.A.,	12 North East Street.
Supervisor of Agricultural Courses for Women.	
ARTHUR K. HARRISON,	6 Allen Street.
Assistant Professor of Landscape Gardening.	
WILLIAM R. HART, LL.B., M.A.,	97 Pleasant Street.
Professor of Agricultural Education and Head of Department.	
PHILIP B. HASBROUCK, B.Sc.,	31 Fearing Street.
Professor of Physics and Head of Department.	
CURRY S. HICKS, B.Pd.,	The Davenport.
Professor of Physical Education and Hygiene and Head of Department.	
MRS. CURRY S. HICKS, ²	The Davenport.
Assistant in Department of Physical Education.	
RICHARD L. HOLDEN, B.Sc.,	14 Nutting Avenue.
Instructor in Animal Husbandry.	
EGERTON G. HOOD, B.Sc.Agr.,	15 Spring Street.
Instructor in Microbiology.	
ARAO ITANO, Ph.D.,	3 Fearing Street.
Associate Professor of Microbiology.	
LORIAN P. JEFFERSON, M.A.,	84 Pleasant Street.
Assistant Professor in the Division of Rural Social Science.	
HENRY F. JUDKINS, B.Sc.,	103 Butterfield Terrace.
Associate Professor of Dairying.	
ARTHUR N. JULIAN, A.B.,	4 Farview Way.
Assistant Professor of German.	

¹ On leave of absence.² Temporary position.

EDWARD M. LEWIS, A.M.,	19 Lincoln Avenue.
Professor of Language and Literature and Head of Department.	
JOSEPH B. LINDSEY, Ph.D.,	47 Lincoln Avenue.
Goessmann Professor of Agricultural Chemistry and Head of Department.	
WILLIAM P. B. LOCKWOOD, M.Sc.,	34 North Prospect Street.
Professor of Dairying and Head of Department.	
WILLIAM L. MACHMER, A.M.,	3 Kendrick Place.
Associate Professor of Mathematics.	
ALEXANDER A. MACKIMMIE, A.M.,	Pine Street, North Amherst.
Professor of French.	
CHARLES E. MARSHALL, Ph.D.,	44 Sunset Avenue.
Professor of Microbiology and Head of Department.	
FREDERICK A. McLAUGHLIN, B.Sc.,	15 Fearing Street.
Assistant Professor of Botany.	
ARTHUR M. MCCARTHY, B.Sc.,	120 Pleasant Street.
Assistant in Physical Education.	
JOHN C. McNUTT, B.Sc.Agr.,	7 East Pleasant Street.
Professor of Animal Husbandry and Head of Department.	
FREDERICK G. MERKLE, M.Sc.,	North East Street.
Instructor in Agronomy.	
FRANK C. MOORE, A.B.,	10 Allen Street.
Assistant Professor of Mathematics.	
ROBERT W. NEAL, A.M.,	8 Woodside Avenue.
Associate Professor of English.	
JOHN B. NEWLON,	94 Pleasant Street.
Instructor in Rural Engineering.	
JOSEPH F. NOVITSKI, ¹	6 Phillips Street.
Assistant in Rural Sociology.	
A. VINCENT OSMUN, M.Sc.,	16 Northampton Road.
Professor of Botany and Head of Department.	
JOHN E. OSTRANDER, A.M., C.E.,	33 North Prospect Street.
Professor of Mathematics and Civil Engineering and Head of Department.	
JAMES B. PAIGE, B.Sc., D.V.S.,	42 Lincoln Avenue.
Professor of Veterinary Science and Head of Department.	
LAURENCE H. PARKER, A.B.,	The Davenport.
Instructor in Mathematics.	
CHARLES H. PATTERSON, A.M.,	26 Lincoln Avenue.
Professor of English.	
LOYAL F. PAYNE, B.Sc.,	33 East Pleasant Street.
Associate Professor of Poultry Husbandry, Acting Head of Department.	
CHARLES A. PETERS, Ph.D.,	Sunset Place.
Professor of Inorganic and Soil Chemistry.	
JOHN PHELAN, A.M.,	5 Mount Pleasant.
Professor of Rural Sociology and Head of Department.	
WALTER E. PRINCE, A.M.,	25 Amity Street.
Assistant Professor of English.	
GEORGE F. PUSHEE,	North Amherst.
Shop Assistant in Rural Engineering.	
FRANK P. RAND, M.A.,	North Amherst.
Instructor in English.	
WILLIAM S. REGAN, Ph.D.,	84 Pleasant Street.
Associate Professor of Entomology.	
VICTOR A. RICE, B.S.Agr.,	Mount Pleasant.
Assistant Professor of Animal Husbandry.	
HAROLD E. ROBBINS, A.M.,	4 Nutting Avenue.
Associate Professor of Physics.	
DONALD W. SAWTELLE, M.Sc.,	13 Fearing Street.
Instructor in Agricultural Economics.	
FRED C. SEARS, M.Sc.,	Mount Pleasant.
Professor of Pomology and Head of Department.	
PAUL SEREX, Jr., M.Sc.,	5 East Pleasant Street.
Instructor in Chemistry.	

¹ On leave of absence.

EDNA L. SKINNER, B.Sc.,	50 Lincoln Avenue.
Professor of Home Economics and Head of Department.	
LELAND SPENCER, B.Sc., ¹	24 Pleasant Street.
Instructor in Farm Management.	
ROBERT J. SPRAGUE, Ph.D.,	Mount Pleasant.
Professor of Economics and Sociology, Head of Department, Head of Division of the Humanities.	
JAMES L. STRAHAN, M.Sc.,	24 Pleasant Street.
Assistant Professor of Rural Engineering.	
CHARLES H. THAYER,	Hickory Farm, Amherst.
Instructor in Agronomy.	
CLARK L. THAYER, B.Sc.,	The Davenport.
Associate Professor of Floriculture and Head of Department.	
CHARLES H. THOMPSON, M.Sc.,	Mount Pleasant.
Assistant Professor of Horticulture.	
HAROLD F. TOMPSON, B.Sc.,	10 Temple Street, Arlington.
Professor of Vegetable Gardening and Head of Department.	
RAY E. TORREY, Ph.D.,	24 Pleasant Street.
Instructor in Botany.	
STANLEY E. VANHORN,	North Amherst.
Instructor in Dairying.	
RICHARD W. WALKER, Lieut. Col., U. S. A.,	21 Northampton Road.
Professor of Military Science and Tactics.	
GILBERT S. WATTS, B.Sc.,	12 Nutting Avenue.
Instructor and Foreman, Vegetable Gardening.	
FRANK A. WAUGH, M.Sc.,	Campus.
Professor of Landscape Gardening, Head of Department, Head of Division of Horticulture.	
WINTHROP S. WELLES, B.Sc.,	21 Lincoln Avenue.
Professor of Agricultural Education.	
CHARLES WELLINGTON, Ph.D.,	34 Amity Street.
Professor of Chemistry.	
FRED E. WHEELER, B.Sc.,	24 Pleasant Street.
Instructor in Dairying.	
T. G. YAXIS, M.Sc., ²	Tillson Court.
Assistant Professor of Dairying.	
—	—
Professor of Chemistry.	
—	—
Associate Professor of Beekeeping.	
—	—
Instructor in French.	
—	—
Associate Professor of Rural Sociology.	

THE EXPERIMENT STATION STAFF.

KENYON L. BUTTERFIELD, A.M., LL.D.,	President's House.
President of the College.	
FRED W. MORSE, M.Sc.,	40 Pleasant Street.
Acting Director and Research Chemist.	
JAMES R. ALCOCK,	North Amherst.
Assistant in Animal Nutrition.	
HARRY L. ALLEN,	89 Main Street.
Laboratory Assistant.	
PAUL J. ANDERSON, Ph.D.,	McClure Street.
Associate Plant Pathologist.	
ALYN S. BALL,	11 Whitney Street.
Laboratory Assistant.	
CARLOS L. BEALS, M.Sc.,	10 Nutting Avenue.
Assistant Chemist.	

¹ Temporary appointment.² Appointment to take effect Jan. 1, 1920.

ARTHUR I. BOURNE, B.A., Assistant Entomologist.	12 East Pleasant Street.
ETHEL BRADLEY, B.Sc., Assistant Chemist.	79 Pleasant Street.
WILLIAM P. BROOKS, Ph.D., Consulting Agriculturist.	6 Farview Way.
ALEXANDER E. CANCE, Ph.D., Professor of Agricultural Economics.	9 Fearing Street.
GEORGE H. CHAPMAN, Ph.D., Research Physiologist.	31 Lincoln Avenue.
WALTER W. CHENOWETH, M.Sc., Professor of Horticultural Manufactures.	North Amherst.
ARTHUR M. CLARKE, B.A., Assistant Chemist.	123 South Pleasant Street.
ORTON L. CLARK, B.Sc., Assistant Plant Physiologist.	16 College Street.
ROBERT L. COFFIN, Assistant in Agriculture.	19 Phillips Street.
HENRY T. FERNALD, Ph.D., Entomologist.	44 Amity Street.
HENRY J. FRANKLIN, Ph.D., In charge of Cranberry Investigations.	East Wareham.
GEORGE E. GAGE, A.B., M.A., Ph.D., Associate Professor of Animal Pathology.	2 Farview Way.
EDWIN F. GASKILL, B.Sc., Assistant Agriculturist.	North Pleasant Street.
HUBERT D. GOODALE, Ph.D., Research Biologist in Poultry Husbandry.	North Amherst.
JOHN C. GRAHAM, B.Sc., ¹ Professor of Poultry Husbandry.	Lincoln Avenue.
HENRI D. HASKINS, B.Sc., Chemist in charge of Fertilizer Section.	14 Amity Street.
EDWARD B. HOLLAND, Ph.D., Associate Chemist in charge of Research Section.	28 North Prospect Street.
JAMES T. HOWARD, Inspector.	46 Pleasant Street.
THOMAS G. HULL, Ph.D., ² Assistant in Veterinary Science.	103 Butterfield Terrace.
MARGUERITE G. ICKIS, M.A., Curator, Department of Botany.	The Davenport.
ARAO ITANO, Ph.D., Associate Professor of Microbiology.	3 Fearing Street.
CARLETON P. JONES, M.Sc., Assistant Chemist.	8 Nutting Avenue.
WEBSTER S. KROUT, B.Sc., M.A., Field Plant Pathologist.	46 Pleasant Street.
JOSEPH B. LINDSEY, Ph.D., Vice-Director and Chemist.	47 Lincoln Avenue.
CHARLES E. MARSHALL, Ph.D., Professor of Microbiology.	44 Sunset Avenue.
ANNE C. MESSER, A.B., Assistant Chemist.	8 Allen Street.
A. VINCENT OSMUN, M.Sc., Botanist.	16 Northampton Road.
JOHN E. OSTRANDER, A.M., C.E., Meteorologist.	33 North Prospect Street.
JAMES B. PAIGE, B.Sc., D.V.S., Veterinarian.	42 Lincoln Avenue.
FRED C. SEARS, M.Sc., Professor of Pomology.	Mount Pleasant.
PHILIP H. SMITH, M.Sc., Chemist in charge of Feed and Dairy Section.	102 Main Street.

¹ On leave of absence.² Temporary appointment.

HAROLD F. TOMPSON, B.Sc.,	10 Temple Street, Arlington.
In charge of Market Garden Field Station.	
LEWELL S. WALKER, B.Sc.,	19 Phillips Street.
Assistant Chemist.	
FRANK A. WAUGH, M.Sc.,	Campus.
Head of Division of Horticulture.	
Assistant Professor of Agricultural Economics.	
Assistant Chemist.	
Investigator, Entomology.	
Research Pomologist.	

THE EXTENSION SERVICE STAFF.

KENYON L. BUTTERFIELD, A.M., LL.D.,	President's House.
President of the College.	
JOHN D. WILLARD, B.A., ¹	East Pleasant Street.
Director.	
L. WAYNE ARNY, B.Sc.,	7 Allen Street.
Supervisor of Correspondence Courses and Editor of Extension Service Publications.	
LINCOLN W. BARNES, B.Sc., ²	50 Amity Street.
Extension Assistant Professor of Agricultural Education.	
WILLIAM R. COLE,	5 East Pleasant Street.
Extension Specialist in Food Preservation.	
LAURA COMSTOCK,	84 Pleasant Street.
Extension Professor of Home Economics.	
ROY B. COOLEY, B.S.A.,	54 Pleasant Street.
Extension Assistant Professor of Animal Husbandry.	
GEORGE L. FARLEY, M.Sc.,	22 Dana Street.
Supervisor of Junior Extension Work.	
LAURA R. GIFFORD,	5 School Street.
Assistant Leader of Rural Home Economics Projects.	
HENRY E. HASLETT, B.Sc.,	Lincoln Avenue.
Extension Specialist in Sheep Husbandry.	
WILLIAM F. HOWE,	8 North Prospect Street.
Assistant Supervisor of Junior Extension Work.	
DELOS L. JAMES, B.Sc.,	6 Kellogg Avenue.
Extension Specialist in Dairying.	
EARL JONES, M.Sc.,	8 Allen Street.
Extension Associate Professor of Agronomy.	
WILLIAM C. MONAHAN, B.Sc.,	34 Pleasant Street.
Extension Assistant Professor of Poultry Husbandry.	
EZRA L. MORGAN, A.M., ³	
Extension Professor of Community Planning.	
EARLE H. NODINE, ²	24 Pleasant Street.
Extension Instructor in charge of Poultry Club Work.	
HELEN M. NORRIS,	87 Pleasant Street.
Extension Instructor in Agricultural Education.	
SUMNER R. PARKER, B.Sc.,	51 Amity Street.
Extension Professor of Rural Organization and County Agent Leader.	
RALPH W. REDMAN, B.Sc.,	1 Mount Pleasant.
Assistant Director, Acting Director, 1919.	
Mrs. RUTH S. REED, ²	
Extension Assistant Professor of Home Economics.	
RALPH A. VAN METER, B.Sc.,	1 Bank Block.
Extension Instructor in Pomology.	

¹ Appointment to take effect Jan. 1, 1920.² Temporary position.³ On leave of absence.

JOHN D. WILLARD, B.A.,	East Pleasant Street.
Extension Professor of Agricultural Economics.	
JOHN D. ZINK, B.Sc.,	College Avenue.
Assistant to the Director.	
Assistant Professor of Farm Management.	
Assistant Professor of Landscape Gardening.	
Assistant Professor of Agricultural Economics.	
Assistant Professor of Vegetable Gardening.	

THE CLERICAL STAFF.

NELLIE V. BARKHOUSE,	Lincoln Avenue.
Clerk, Department of Rural Home Life.	
ELEANOR F. BISHOP,	3 Spaulding Street.
Bookkeeper, Treasurer's Office.	
EVELYN BREWSTER, B.Sc.,	79 Pleasant Street.
Private Secretary, President's Office.	
JOHN K. BROADFOOT,	130 Pleasant Street.
Cashier, Treasurer's Office.	
MARY L. BROADFOOT,	130 Pleasant Street.
Clerk, Treasurer's Office.	
RUTH BROOKS,	9 Phillips Street.
Clerk, Treasurer's Office.	
LUCIA G. CHURCH,	North Amherst.
First Clerk, Experiment Station.	
SUSAN L. CLARK, ¹	Northampton.
Stenographer, Extension Service.	
GRACE COLBURN,	Care of Mrs. H. D. Fearing.
Clerk, Treasurer's Office.	
IRENE CRUTCH,	South Amherst.
Clerk, Division of Agriculture.	
VIOLA E. DAMON,	Bank Block.
Clerk, Department of Floriculture.	
EMILY G. DAVIDSON,	10 Maple Avenue.
Telephone Operator.	
MARGARET G. DAVIDSON,	10 Maple Avenue.
Clerk, Extension Service.	
LLEWELYN L. DERBY,	81 Pleasant Street.
Assistant, Department of Physical Education.	
MARION F. DONDALE, A.B.,	15 Spring Street.
Clerk, Graduate School and Department of Microbiology.	
NOELLIA C. DUVAL,	34 McClellan Street.
Clerk, Power Plant.	
CHARLOTTE E. ERICKSON,	Florence.
Clerk, Treasurer's Office.	
F. ETHEL FELTON, A.B.,	8 Allen Street.
Clerk and Editorial Assistant, Experiment Station.	
MELINA M. FISHER,	28 Pleasant Street.
Clerk, Department of Chemistry.	
GRACE E. GALLOND,	28 Pleasant Street.
Clerk, Department of Dairying.	
KATHERINE GARDNER, A.B.,	87 Pleasant Street.
Clerk, Division of Agriculture.	
MARGARET T. GASKELL,	105 Main Street.
Clerk, Registrar's Office.	
CORA B. GROVER,	North Amherst.
Clerk, Experiment Station.	

¹ Appointment to take effect Dec. 4, 1919.

LILLIAN S. HADFIELD, ...	16 Nutting Avenue.
Clerk, Extension Service.	
LAURA W. HAGER, A.B., ...	Bank Block.
Clerk, Department of Agricultural Economics.	
AMY H. HAMILTON, ...	Savings Bank Block.
Stenographer, Division of Rural Social Science.	
CATHERINE A. HARRINGTON, ...	62 Main Street.
Stenographer, Department of Agricultural Economics.	
MARION E. HAWTHORNE, ...	South Amherst.
Stenographer, Extension Service.	
MARY E. HORTON, ...	79 Pleasant Street.
Clerk, Department of Rural Sociology.	
ELIZABETH M. KILEY, ...	Northampton.
Clerk, Department of Entomology.	
MARGUERITE C. LEDUC, ...	Northampton.
Clerk, Extension Service.	
HONORIA A. LEE, ...	38 Cottage Street.
Clerk, Division of Horticulture.	
HELEN A. MARTIN, ...	5 Phillips Street.
Clerk, Treasurer's Office.	
REBECCA L. MELLOR, ...	10 Kellogg Avenue.
First Clerk, Experiment Station.	
MARIE MERCIER, ...	Northampton.
Stenographer, Short Courses.	
GLADYS I. MINER, ...	73 Pleasant Street.
Clerk, Extension Service.	
BRIDIE E. O'DONNELL, ...	Hadley.
Clerk, Department of Entomology.	
RACHEL C. PACKARD, ...	22 North Prospect Street.
Clerk, President's Office.	
HELEN L. PHILLIPS, ...	13 Amity Street.
Clerk, Extension Service.	
MILDRED PIERPONT, A.B., ...	12 East Pleasant Street.
Clerk, Short Courses.	
FRANCES E. POWERS, ...	44 Lincoln Avenue.
Stenographer, Department of Dairying.	
JESSIE M. PRINCE, B.A., ...	Care of Mrs. H. D. Fearing.
First Clerk, Extension Service.	
EDITH ROBINSON, ...	73 Pleasant Street.
Clerk, President's Office.	
LAURA H. SABIN, ...	15 Phillips Street.
Stenographer, Department of Poultry Husbandry.	
RUBY SANBORN, A.B., ...	45 Pleasant Street.
Clerk, Department of Poultry Husbandry.	
MARY I. SHORES, ...	35 South Pleasant Street.
Clerk, Dean's Office.	
MARJORIE T. SILCOX, ...	73 Pleasant Street.
Clerk, President's Office.	
ELIZABETH STRACHAN, ...	17 High Street.
Clerk, Treasurer's Office.	
ETHELYN STREETER, ...	2 Tyler Place.
Clerk, Division of Horticulture.	
MARJORIE E. SULLIVAN, ...	55 Amity Street.
Clerk, Division of Agriculture.	
ALINE B. SURPRENANT, ...	44 Triangle Street.
Clerk, Extension Service.	
CLARA A. SWIFT, ...	North Amherst.
Clerk, Extension Service.	
DORIS C. TOWER, ...	55 Amity Street.
Clerk, Department of Poultry Husbandry.	
OLIVE M. TURNER, B.Sc., ...	22 Spaulding Street.
Clerk, Registrar's Office.	

MARION D. WARNER, ...	12 East Pleasant Street.
First Clerk, Division of Agriculture.	
ELLEN L. WELCH, B.A., ...	East Hadley.
Clerk, Department of Botany.	
_____.	- -
Clerk, Dean's Office.	
_____.	- -
Clerk, Department of Dairying.	

THE LIBRARY STAFF.

CHARLES R. GREEN, B.Agr., ...	Mount Pleasant.
Librarian.	
LENA V. CHAPMAN, ...	77 South Pleasant Street.
Assistant in charge of Circulation.	
LALIA M. DAMON, ...	2 McClellan Street.
Cataloguer.	
LOUISE J. DELANO, B.Sc., ...	87 Pleasant Street.
Department Librarian.	
LOTTIE M. FOSDICK, B.A., ...	87 Pleasant Street.
Assistant.	

OTHER OFFICERS.

Mrs. JESSIE BACHARACH, ¹	Draper Hall.
Matron.	
THOMAS F. BUTTERWORTH, ...	3 Phillips Street.
Engineer.	
LAWRENCE S. DICKINSON, B.Sc., ²	2 Farview Way.
Superintendent of Grounds.	
LULU DIETHER, ...	Draper Hall.
Manager of the Dining Hall.	
CLARENCE A. JEWETT, ...	112 Pleasant Street.
Superintendent of Buildings.	
JOHN J. LEE, ...	38 Cottage Street.
Assistant to Military Detail.	
WILLIAM MARTIN, ...	5 Phillips Street.
Laboratory Assistant, Department of Horticultural Manufactures.	
ENOS J. MONTAGUE, B.Sc., ...	Campus.
Farm Superintendent.	
ELIZABETH OLMSTEAD, ...	Infirmary.
Resident Nurse.	
ALMON W. SPAULDING, B.Sc., ...	The Davenport.
Field Agent.	
JAMES WHITING, ...	16 Hallock Street.
Foreman, Department of Floriculture.	

GRADUATE ASSISTANTS.

DANIEL A. ALBRECHT, B.A., B.Sc., ...	Clark Hall.
Department of Botany.	
ROY C. AVERY, B.Sc., ...	15 Spring Street.
Department of Microbiology.	
AMBROSE C. FANEUF, B.Sc., ...	Chemistry Laboratory.
Department of Chemistry.	
MARY E. GARVEY, B.Sc., ...	27 South Prospect Street.
Department of Microbiology.	
ARTHUR H. HELDER, M.Sc., ...	24 Pleasant Street.
Department of Landscape Gardening.	
CHARLES H. JEWELL, B.Sc., ...	Chemistry Laboratory.
Department of Chemistry.	

¹ Temporary position.² On leave of absence.

CONRAD H. LIEBER, B.Sc., ...	3 Nutting Avenue.
Department of Microbiology.	
ALFRED S. MALLOREY, B.Sc., ...	15 Hallock Street.
Department of Agronomy.	
JOSEPH A. MIDDLETON, B.Sc., ...	24 Pleasant Street.
Department of Pomology.	
JAMES NEILL, B.Sc., ...	5 McClellan Street.
Department of Microbiology.	
JAMES A. PURINGTON, B.Sc., ...	5 East Pleasant Street.
Department of Agronomy.	
RUSSELL D. STURGIS, B.Sc., ...	5 Nutting Avenue.
Department of Chemistry.	
LESLIE C. WHITAKER, B.Sc., ...	30 North Prospect Street.
Department of Microbiology.	
OLIVER W. WOOD, B.Sc., ...	North College.
Department of Poultry Husbandry.	

STANDING COMMITTEES OF THE FACULTY.

1919-20.

CATALOGUE AND OTHER PUBLICATIONS.

Associate Professor NEAL.
Secretary WATTS.

COMMENCEMENT.

Dean LEWIS.
Treasurer KENNEY.
Colonel WALKER.
Professor PATTERSON.
Secretary WATTS.
Professor PETERS.
Associate Professor C. L. THAYER.

COURSE OF STUDY.

President BUTTERFIELD.
Dean LEWIS.
Professor HART.
Professor WAUGH.
Professor SPRAGUE.
Professor FERNALD.
Professor OSTRANDER.
Professor MARSHALL.
Professor CHAMBERLAIN.
Professor PHELAN.
Professor FOORD.

DISCIPLINE.

Dean LEWIS.
Professor PATTERSON.
Professor MCNUTT.
Professor PHELAN.
Professor LOCKWOOD.
Professor HICKS.

EMPLOYMENT.

Professor SEARS.
Treasurer KENNEY.
Secretary WATTS.
Associate Professor PAYNE.

ENTRANCE EXAMINATIONS AND ADMISSION.

Professor HASBROUCK.
Professor PATTERSON.
Professor OSMUN.
Associate Professor ASHLEY.

HEALTH AND SANITATION.

Professor MARSHALL.
Treasurer KENNEY.
Professor PATTERSON.
Professor HICKS.
Miss SKINNER.

LIBRARY.

Professor MARSHALL.
Professor SPRAGUE.
Professor CANCE.
Mr. GREEN.

SCHEDULE.

Professor PETERS.
Assistant Professor JULIAN.
Mr. L. H. PARKER.

SCHOLARSHIP.

Professor PATTERSON.
Professor HASBROUCK.
Professor CHAMBERLAIN.
Mr. RAND.
Professor MACKIMMIE.
Associate Professor MACHMER.
Mr. L. H. PARKER.
Professor HICKS.

STUDENT LIFE.

Professor PATTERSON.
Mr. RAND.
Secretary WATTS.
Professor PHELAN.

ATHLETIC BOARD.

Dean LEWIS.
Professor HASBROUCK.
Professor OSMUN.

NON-ATHLETIC BOARD.

Professor LOCKWOOD.
Professor PATTERSON.

THE COLLEGE

ADMISSION.

A. APPLICATION FOR ADMISSION.

All correspondence concerning admission should be addressed to the registrar.

Every applicant for admission to the college must be at least sixteen years old, and must present to the registrar proper testimonials of good character. Such testimonials, whenever possible, should come from the principal of the school at which the applicant has prepared for college. Candidates who desire to present themselves for examination in any subjects must make application to the college for such privilege at least one month before examination is desired. Blanks for such application may be obtained by addressing the registrar of the college. All entrance credentials must be in the hands of the registrar before the applicant can matriculate.

B. MODES OF ADMISSION.

Students are admitted to the freshman class either upon certificate or upon examination. No *diploma* from a secondary school will be accepted.

CERTIFICATES. — Certificates will be received from those schools in New England which have been approved by the New England College Entrance Certificate Board. Principals of schools in New England who desire the certificate privilege should address the secretary of the Board, Professor Frank W. Nicolson, Wesleyan University, Middletown, Conn. Certificates from schools outside of New England may be received if those schools are on the approved list of the leading colleges of the section in which the school in question is located.

The credentials of the Board of Regents of the State of New York are accepted as satisfying the entrance requirements of this college when offered subject for subject.

Certificates in order to be accepted must present at least three of the necessary fourteen credits. It is to be understood, however, that responsibility for certification in either elementary French, elementary German, English 1 or English 2, Latin A, Greek A or algebra must be assumed by one school, if the candidate has received his preparation in any one subject named above in more than one school. Subjects lacking on certificate (except for the permitted number of conditions) must be made up at the time of the examinations for admission.

Blank forms for certification — sent to principals or school superintendents only — may be obtained on application to the registrar of the college.

EXAMINATIONS. — The examination in each subject may be oral or written, or both. The standard required for passing an examination for admission is 65 per cent. Conditions to the amount of two units will be allowed.

Entrance examination for admission to the Massachusetts Agricultural College will be held at the following centers:—

In June, ... Amherst, Department of Physics building.
Massachusetts Institute of Technology,
Cambridge, Mass.
Worcester, Horticultural Hall.

In September, ... Amherst, Department of Physics building.

Please note that September examinations are held in Amherst only.

Schedule for Entrance Examinations, June 24-26, inclusive, 1920.—The examinations in June will follow this schedule:—

First Day.

7.45 A.M. Registration.
8.00 A.M. Plane geometry.
10.00 A.M. Chemistry.
11.30 A.M. Botany.
2.00 P.M. Solid geometry.
4.00 P.M. Physics.

Second Day.

8.00 A.M. Required English.
11.00 A.M. Algebra.
2.00 P.M. History, required and elective.

Third Day.

8.00 A.M. French, German, required and elective.
1.00 P.M. Latin A and B and all one-half credit electives, except those already noted.

Schedule for Entrance Examinations in September.—In September, 1920, the examinations will be given September 22-25, inclusive, and will follow the order indicated below:—

First Day.

1.00 P.M. Registration.
1.15-5.00 P.M. Greek A and B.

Second Day.

8.00 A.M. Plane geometry.
10.00 A.M. Chemistry.
11.30 A.M. Botany.
2.00 P.M. Solid geometry.
4.00 P.M. Physics.

Third Day.

8.00 A.M. Required English.
11.00 A.M. Algebra, agriculture.
2.00 P.M. History, required and elective.

Fourth Day.

8.00 A.M. French, German, required and elective.
1.00 P.M. Latin A and B and all one-half credit electives, except those already noted.

C. REQUIREMENTS FOR ADMISSION.

The requirements for admission are based on the completion of a four-year high school course, or its equivalent, and are stated in terms of units. The term unit means the equivalent of at least four recitations a week for a school year. **Neither more nor less credit will be given in any subject than is indicated in the table below.** Fourteen units must be offered for admission. In the list given below, *every subject in black-faced type is prescribed and no substitution is allowed.* The subjects so typed total eight and one-half units. In addition to these points five and one-half more units must be chosen from the subjects printed in light-faced type. Not more than four half-credit units may be offered. No applicant deficient in both algebra and plane geometry will be admitted. Entrance credits gained either by certificate or by examination will hold good for one year.

Agriculture, ¹	1 to 4*
Botany, ²	½ or 1
Chemistry, ²	1
Algebra,	1½
Plane geometry,	1
Solid geometry,	½
Trigonometry,	½
Physics, ²	1
Geology,	½
Physical geography,	½
Physiology,	½
Zoölogy, ²	½
History ³ (Ancient; Medieval and Modern; English; General; United States and Civics), <i>any one</i> ,	1 ⁴
English 1,	1½
English 2,	1½
Modern Language (elementary French or elementary German),	2
Elementary French, ⁵	2
Elementary German, ⁵	2
Intermediate French,	1
Advanced French,	1
Intermediate German,	1
Advanced German,	1
Greek A, ¹	2
Greek B, ¹	1
Latin A,	2
Latin B,	1
Commercial geography, ⁵	½
Drawing, ⁶	½
Manual training, ⁶	½ or 1

PRESENTATION OF NOTE-BOOKS.—The keeping of a note-book is required as part of the preparation in those subjects indicated (see note 2, below).

Candidates presenting themselves for examination in such subjects must present at the same time the required note-book, properly certified by the principal. Candidates presenting such subjects on certificates should not present note-books, but their certificates must state that note-books have been satisfactorily completed.

* See page 32 for details.

¹ Examination in September only.

² Note-book required as part of preparation will be credited as part of the examination.

³ One must be offered for the required point; one, two or three others may be offered for elective points.

⁴ For each offered.

⁵ May be offered as elective if not offered to satisfy *prescribed* points.

⁶ On certificate only, no examination given.

D. STATEMENT OF PREPARATION REQUIRED FOR ADMISSION.

AGRICULTURE. — Entrance credit in agriculture is granted on the following basis: —

I. The Massachusetts Agricultural College accepts a maximum of four credits in agriculture from any secondary and county agricultural high school in Massachusetts offering work in that subject, provided: —

1. That a maximum credit of one unit be accepted on certificate from schools approved by the New England College Entrance Certificate Board.

2. That, if further credit be desired from such schools, it may be obtained up to a total of four (including the one credit presented by certificate) for four full calendar years of work, credits in addition to the one credit by certificate to be measured after and determined by examination given by the head of the Division of Agriculture of the Massachusetts Agricultural College.

3. That from all other secondary schools and county agricultural high schools a maximum of four credits in agriculture be accepted for four full calendar years of work, the number of units to be measured after and determined by examinations given by the head of the Division of Agriculture of the Massachusetts Agricultural College.

II. In high schools organizing agricultural club work under the supervision and rules of the junior extension service of the college, 1 credit is granted for each full year of work performed under the following plan: —

Work of the Winter Term. — (a) The study of text-books such as are suitable for secondary school instruction in agriculture.

(b) Course of Study: A general outline of suggested topics for study.

(c) Visits by a representative of the Massachusetts Agricultural College for observation, counsel and advice in regard to kind and amount of work being done in agriculture.

(d) Formation of an agricultural club with officers from among its own members, meeting once a month under local supervision of some one authorized to act for the school authorities.

Work of the Spring Term. — Same in general form as winter term.

Work of the Summer Term. — An approved project conforming to the rules of some one or more of the agricultural clubs of the junior extension service of the Massachusetts Agricultural College.

Work of the Fall Term. — (a) An exhibit of work.

(b) Reports and story of achievement submitted to the junior extension service of the college.

The maximum number of credits in agriculture is 4. The examinations in agriculture are given in September only.

BOTANY. — For one unit of credit in botany, the work outlined in the statement of requirements issued by the College Entrance Examination Board, or its equivalent, will be accepted. This work should occupy one school year and include laboratory and supplementary text-book study. For one-half unit of credit, work that covers the same ground but occupies half the time required for a full unit of credit will be accepted. These requirements are met by such texts as Steven's "Introduction to Botany" and Bergen & Davis's "Principles of Botany." A note-book containing neat, accurate drawings and descriptive records forms part of the requirement for either the half-unit or the one-unit credit, and this note-book must be pre-

sented by all applicants for admission upon examination in this subject. The careful preparation of an herbarium is recommended to all prospective students of this college, although the herbarium is not required.

CHEMISTRY. — The entrance examination in chemistry will cover the work outlined by the College Entrance Examination Board as preparatory for college entrance. In general, this consists of a year of high school chemistry from any standard text-book, with laboratory work on the properties of the common elements and their simpler compounds. No particular work is prescribed. The keeping of a note-book is required.

MATHEMATICS. — (a) *Required.* — Algebra: The four fundamental operations for rational algebraic expressions; factoring, determination of highest common factor and lowest common multiple by factoring; fractions, including complex fractions; ratio and proportion; linear equations, both numerical and literal, containing one or more unknown quantities; problems depending on linear equations; radicals, including the extraction of the square root of polynomials and numbers; exponents, including the fractional and negative; quadratic equations, both numerical and literal; simple cases of equations with one or more unknown quantities that can be solved by the methods of linear or quadratic equations; problems depending upon quadratic equations; the binomial theorem for positive integral exponents, the formulas for the n th term and the sum of the terms of arithmetic and geometric progressions, with applications.

Plane Geometry: The usual theorems and constructions of good text-books, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas; regular polygons and the measurement of the circle; the solution of numerous original exercises, including loci problems; applications to the mensuration of lines and plane surfaces.

(b) *Elective.* — Solid Geometry: The usual theorems and constructions of good text-books, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders and cones; the sphere and spherical triangle; the solution of numerous original exercises, including loci problems; applications to the mensuration of surfaces and solids.

Plane Trigonometry: A knowledge of the definitions and relations of trigonometric functions and of circular measurements and angles; proofs of the principal formulas and the application of these formulas to the transformation of the trigonometric functions; solution of trigonometric equations, the theory and use of logarithms, and the solution of right and oblique triangles.

PHYSICS. — To satisfy the entrance requirement in physics, the equivalent of at least one unit of work is required. This work must consist of both class-room work and laboratory practice. The work covered in the class-room should be equal to that outlined in Hall & Bergen's "Text-book of Physics" or Millikan & Gale; the laboratory work should represent at least thirty-five experiments involving careful measurements, with accurate recording of each in laboratory note-book. This note-book, certified by the instructor in the subject, must be submitted by each candidate presenting himself for examination in physics; credit for passing the subject will be given on laboratory notes and on the examination paper submitted. Candidates entering on certificate will not be required to present note-books, but the principal's certification must cover laboratory as well as class-room work.

PHYSIOLOGY. — Hough & Sedgwick's "The Human Mechanism;" Martin's "The Human Body; Briefer Course."

ZOOLOGY, PHYSICAL GEOGRAPHY, GEOLOGY. — The following suggestions are made concerning preparation for admission in the subjects named above: —

For physiography, Davis' "Elementary Physical Geography;" Gilbert & Brigham's "Introduction to Physical Geography." For zoölogy, text-books entitled "Animals" or "Animal Studies," by Jordan, Kellogg and Heath; Linville & Kelley's "A Text-book in General Zoölogy." For geology, A. P. Brigham's "A Text-book of Geology" or Tarr's "Elementary Geology."

Applicants for examination in zoölogy are *required* to present certified laboratory note-books; applicants for examination in the other subjects are *advised* to present note-books, if laboratory work has been done. Good note-books may be given credit for entrance. Examination in these subjects will be general, in recognition of the different methods of conducting courses; but students will be examined on the basis of the most thorough secondary school courses.

HISTORY. — The required unit must be offered in either ancient history, medieval and modern history, English history, general history, or United States history and civics. Either one, two or three elective units in any of the historical subjects here named may be offered, provided that no unit be offered in the same subject in which the required unit has been offered.

Preparation in history will be satisfactory if made in accordance with the recommendations of the committee of seven of the American Historical Association, as outlined by the College Entrance Examination Board. The examination will require comparisons and the use of judgment by the candidate rather than the mere use of memory, and it will presuppose the use of good text-books, collateral reading and practice in written work. Geographical knowledge may be tested by requiring the location of places and movements on outline maps.

To indicate in a general way the character of the text-book work expected, the texts of the following authors are suggested: Botsford, Morey or Myers, in ancient history (to 814 A.D.); Adams, West or Myers, in medieval history; Montgomery, Larned or Cheyney, in English history; Myers or Fisher, in general history; Fiske, together with MacLaughlin or Montgomery, in United States history and civics.

ENGLISH. — The study of English in school has two main objects, which should be considered of equal importance: (1) command of correct and clear English, spoken and written; (2) ability to read with accuracy, intelligence and appreciation, and the development of the habit of reading good literature with enjoyment.

(1) *Grammar and Composition* (One and One-half Units). — The first object requires instruction in grammar and composition. English grammar should ordinarily be reviewed in the secondary school; and correct spelling and grammatical accuracy should be rigorously exacted in connection with all written work during the four years. The principles of English composition governing punctuation, the use of words, sentences and paragraphs should be thoroughly mastered; and practice in composition, oral as well as written, should extend throughout the secondary school period. Written exercises may well comprise letter-writing, narration, description and easy exposition and argument. It is advisable that subjects for this work be taken from the student's personal experience, general knowledge and studies other than English, as well as

from his reading in literature. Finally, special instruction in language and composition should be accompanied by concerted effort of teachers in all branches to cultivate in the student the habit of using good English in his recitations and various exercises, whether oral or written.

(2) *Literature* (One and One-half Units). — The second object is sought by means of two lists of books, headed, respectively, "Reading" and "Study," from which may be framed a progressive course in literature covering four years. In connection with both lists the student should be trained in reading aloud and encouraged to commit to memory some of the more notable passages both in verse and in prose. As an aid to literary appreciation, he is further advised to acquaint himself with the most important facts in the lives of the authors whose works he reads and with their place in literary history.

A. *Books for Reading*. — The aim of this course is to foster in the student the habit of intelligent reading and to develop a taste for good literature by giving him a first-hand knowledge of some of its best specimens. He should read the books carefully, but his attention should not be so fixed upon details that he fails to appreciate the main purpose and charm of what he reads.

The books provided for reading are arranged in the following groups, from each of which at least two selections are to be made, except that for any book in Group I. a book from any other may be substituted.

GROUP I. CLASSICS IN TRANSLATION.

The "Old Testament," at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings and Daniel, together with the books of Ruth and Esther.

The "Odyssey," with the omission, if desired, of Books I-V, XV and XVI.

The "Æneid."

The "Odyssey" and the "Æneid" should be read in English translations of recognized literary excellence.

GROUP II. DRAMA.

Shakespeare: "Merchant of Venice," "As You Like It," "Julius Cæsar."

GROUP III. PROSE FICTION.

Dickens: "A Tale of Two Cities."

George Eliot: "Silas Marner."

Scott: "Quentin Durward."

Hawthorne: "The House of the Seven Gables."

GROUP IV. ESSAYS, BIOGRAPHY, ETC.

Addison and Steele: "The Sir Roger de Coverly Papers."

Irving: "The Sketch Book," selections covering about 175 pages.

Macaulay: "Lord Clive."

Parkman: "The Oregon Trail."

GROUP V. POETRY.

Tennyson: "The Coming of Arthur," "Gareth and Lynette," "Lancelot and Elaine," "The Passing of Arthur."

Browning: "Cavalier Tunes," "The Lost Leader," "How They Brought the Good News from Ghent to Aix," "Home Thoughts from Abroad," "Home Thoughts from the Sea," "Incident of the French Camp," "Herve Riel," "Pheidippides," "My Lost Duchess," "Up at a Villa—Down in the City," "The Italian in England," "The Patriot," "The Pied Piper," "De Gustibus," "Instans Tyrannus."

Scott: "The Lady of the Lake."

Coleridge: "The Ancient Mariner."

Arnold: "Sohrab and Rustum."

B. Books for Study.—This part of the requirement is intended as a natural and logical continuation of the student's earlier reading, with greater stress laid upon form and style, the exact meaning of words and phrases, and the understanding of allusions. The books provided for study are arranged in four groups, from each of which one selection is to be made.

The books provided for study are arranged in four groups, from each of which one selection is to be made.

GROUP I. DRAMA.

Shakespeare: "Macbeth," "Hamlet."

GROUP II. POETRY.

Milton: "L'Allegro," "Il Penseroso," "Comus."

Book IV of Palgrave's "Golden Treasury" (first series), with special attention to Wordsworth, Keats and Shelley.

GROUP III. ORATORY.

Burke: "Speech on Conciliation with America." *

Washington's "Farewell Address," Webster's "First Bunker Hill Oration," and Lincoln's "Gettysburg Address."

GROUP IV. ESSAYS.

Macaulay: "Life of Johnson."

Carlyle: "Essay on Burns," with a brief selection from Burns's poems.

Examination.—However accurate in subject-matter, no paper will be considered satisfactory if seriously defective in punctuation, spelling or other essentials of good usage.

The examination will be divided into two parts, one of which will be on grammar and composition, and the other on literature.

In grammar and composition, the candidate may be asked specific questions upon the practical essentials of these studies, such as the relation of the various parts of a sentence to one another, the construction of individual words in a sentence of reasonable difficulty, and those good usages of modern English which one should know in distinction from current errors. The main test in composition will consist of one or more essays, developing a theme through several paragraphs; the subjects will be drawn from the books read, from the candidate's other studies and from his personal knowledge and experience quite apart from reading.

The examination in literature will include:—

(a) General questions designed to test such a knowledge and appreciation of literature as may be gained by fulfilling the requirements defined under "A, Reading," above.

(b) A test on the books prescribed for study, which will consist of questions upon their content and structure, and upon the meaning of such words, phrases and allusions as may be necessary to an understanding of the works and an appreciation of their salient qualities of style. General questions may also be asked concerning the lives of the authors, their works and the periods of literary history to which they belong.

FRENCH.—Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary French recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year French (elective subjects for admission). — For a third credit unit in French as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in French will be given unless the candidate has presented elementary French on certificate, or has written the examination in elementary French.

No examination for a fourth credit in French will be given unless the candidate has presented both elementary and intermediate French upon certificate, or has written the examination in both elementary and intermediate French.

GERMAN. — Elementary: The entrance requirements in German conform to those of the College Entrance Examination Board for elementary German (the standard two-year requirements).

Third and fourth year German (elective subjects for admission). — For a third credit unit in German as an elective subject for entrance, when required units have been offered in German, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in German will be given unless the candidate has presented elementary German upon certificate, or has written the examination in elementary German.

No examination for a fourth credit in German will be given unless the candidate has presented both elementary and intermediate German upon certificate, or has written the examination for both elementary and intermediate German.

GREEK. — Greek will receive credit as an elective requirement upon either examination or certification, as follows. (**The examination in Greek A and Greek B will be given in September only.**)

A. Two credit units will be allowed if satisfactory proficiency is shown (including grammar) in (a) the translation of a passage or passages taken from the first four books of Xenophon's "Anabasis," and (b) the translation of passages of Attic prose at sight.

B. A third credit unit will be allowed if, in addition to the above, satisfactory proficiency be shown in (a) the translation of a passage or passages from the first six books of Homer's "Iliad," and (b) translation of passages of Homer's "Iliad" at sight, with questions on the form and constructions of the passages.

LATIN. — Latin will receive credit as an elective requirement upon either examination or certification, as follows: —

A. Two credit units will be allowed if satisfactory proficiency is shown (including grammar) in (a) the translation of a passage or passages taken from Cæsar's "Gallic War," covering at least four books, and (b) the translation of passages of Latin prose at sight.

B. A third credit unit will be allowed if, in addition to the above, satisfactory proficiency be shown in (a) the translation of a passage or passages selected from either Books I. to VI. of Virgil's "Æneid," or six orations of Cicero, including those against Catiline; and (b) the translation into Latin prose of a passage of connected English narrative based on some portion of Cæsar's "Gallic War," Books I. to IV.

COMMERCIAL GEOGRAPHY.¹ — Preparation should be made in a course equivalent to that laid down in Adams' "Commercial Geography," Trotter's "Geography of Commerce," or a similar work. (No examination given.)

DRAWING.¹ — The applicant may offer either freehand or mechanical drawing or both. He must be able to make an accurate freehand sketch, in either outline or light and shade, of the appearance of a group of geometric solids, and have a sufficient knowledge of perspective to enable him to draw correctly a simple geometric model from memory; or, if he present mechanical drawing, he must have working familiarity with drawing instruments, and be able to make an accurate inked working drawing, in orthographic projection, of some simple object. Emphasis is laid on facility in doing good freehand lettering. For a limitation of the work that may be presented, see "Manual Training." (No examination given.)

MANUAL TRAINING.¹ — An entrance credit of one-half or one unit is allowed for manual training, on the presentation of a certificate from the principal of the school showing the scope and character of the applicant's work. The preparation may include mechanical drawing, working in wood, metals, leather, etc. When mechanical drawing is presented as a part of the work in manual training, no other credit for drawing will be allowed. No examination is given in this subject; applicants must present certificates to secure credit.

E. ADMISSION TO ADVANCED STANDING.

Candidates for admission to advanced standing, in addition to meeting the regular entrance requirements, must also pass examinations in those subjects already pursued by the class they desire to enter. To meet this requirement, a student transferring to this college from another college or university of recognized standing must present the following credentials: —

1. A letter of honorable dismissal from the institution with which he has been connected.
2. A statement or certificate of his entrance record.
3. A statement from the proper officer showing a complete record of his work while in attendance.
4. A marked catalogue showing the courses pursued.

These credentials should be presented to the registrar. Applications will be judged wholly on their merits and the college may prescribe additional tests before accepting applicants or determining the standing to be granted them.

F. OTHER INFORMATION ABOUT ENTRANCE.

1. The privileges of the college may be withdrawn from any student at any time if such action is deemed advisable. (It is immaterial whether the pupil has entered by certificate or by examination.)

2. The examination in each subject may be either oral or written, or both. The standard required for passing an entrance examination is 65 per cent.

3. Candidates must receive credit for twelve units out of the total number required for entrance, and will be conditioned in those subjects not passed. Not more than five and one-half credits from the elective group will be accepted. No candidate deficient in both algebra and plane geometry will be admitted.

¹ On certificate only; no examination given.

4. Examinations for the removal of entrance conditions will be held as follows: (1) First entrance condition examination during the first week of the second term. (2) Second entrance condition examination before the beginning of the period of final examinations of the second term, upon the payment of a fee of \$5 to the treasurer.

5. Credits for entrance requirements, whether gained by certificate or by examination, will hold good for one year.

6. Examinations in part of the subjects required for entrance may be taken one year before entering college.

7. For information concerning expenses, scholarships, etc., see "General Information."

8. For information concerning admission to short courses see "Short Courses."

G. UNCLASSIFIED STUDENTS.

All requests for information concerning admission of unclassified students should be addressed to Dean Edward M. Lewis, chairman of committee on unclassified students.

Students not candidates for a degree (unclassified students) are admitted under the following provisions:—

1. All unclassified students are subject to the supervision of a special committee.

2. No applicant under eighteen years of age will be admitted as an unclassified student.

3. No entrance examination is required, but applicants must bring certificates showing that they have finished a four-year high school course or its equivalent, or that they are graduates of a county agricultural school of Massachusetts, and furnish satisfactory testimonials as to moral character.

4. No student of this or any other institution who has not done efficient work therein shall be permitted to register as an unclassified student.

5. Each unclassified student must take from the regular technical elective courses, and necessary prerequisites, a minimum of twelve credit hours a week.

6. In order to be admitted to any course, an unclassified student must have had all prerequisite subjects for that course.

7. Every unclassified student must do all the work of the courses elected, and take all examinations therein. In order to pass such courses he must attain a grade of at least 60 per cent. An unclassified student who passes in less than 60 per cent of his work will be dropped from college.

8. Any unclassified student may be dropped from college at any time if his presence in any class is undesirable or his work is unsatisfactory; and no unclassified student will be allowed to remain in college more than six terms without the special permission of the faculty.

9. No unclassified student shall be allowed to participate in any inter-collegiate contests.

10. Unclassified students are subject to the general regulations applying to classified students.

11. Every unclassified student should clearly understand that before any application for transfer to the regular registration for the Bachelor of Science degree will be considered by the registrar, he must present all entrance credits either by certificate or by examination in the same way as is required of a student who enters regularly.

COURSES OF INSTRUCTION.

TABLE OF FRESHMAN AND SOPHOMORE SUBJECTS.

[The figures indicate the number of credit hours a week. For details, see the descriptions of courses.]

FRESHMAN YEAR.

FIRST TERM.

All work required.

SUBJECT.	Courses and Numbers.	Credit Hours per Week.
Chemistry, ...	Chemistry 1 or 4, ...	3
Algebra, ...	Mathematics 1, ...	5
Language, ...	French or German 1 or 4, ...	3
English, ...	English 1, ...	3
Agriculture, ...	Agronomy 1, Horticulture 1, ...	3
Tactics, ...	Military 1, ...	1
Drill, ...	Military 4, ...	1
Hygiene, ...	Physical Education 1, ...	1
Public speaking, ...	Public Speaking 1 (one-third of the class), ...	1
		21

College life (attendance without credit).

SECOND TERM.

Chemistry, ...	Chemistry 2 or 5, ...	3
Algebra, ...	Mathematics 2, ...	2
Trigonometry, ...	Mathematics 5, ...	3
Language, ...	French or German 2 or 5, ...	3
English, ...	English 2, ...	3
Agriculture, ...	Poultry 1, Animal Husbandry 1, ...	3
Tactics, ...	Military 2, ...	1
Drill, ...	Military 5, ...	1
Geology, ...	Geology 2, ...	2
Public speaking, ...	Public Speaking 1 (one-third of class), ...	1
		22

College life (attendance without credit).

FRESHMAN YEAR — *Concluded.*

THIRD TERM.

SUBJECT.	Courses and Numbers.	Credit Hours per Week.
Chemistry, ...	Chemistry 3 or 6, ...	3
Solid geometry, ...	Mathematics 3, ...	3
Mensuration, ...	Mathematics 6, ...	2
Language, ...	French or German 3 or 6, ...	3
English, ...	English 3, ...	3
Botany, ...	Botany 3, ...	3
Tactics, ...	Military 3, ...	1
Drill, ...	Military 6, ...	1
Recreation, ...	Physical Education 3, ...	1
Public speaking, ...	Public Speaking 1 (one-third of class), ...	1
		21

College life (attendance without credit).

SOPHOMORE YEAR.

FIRST TERM.

SUBJECT.	Course Number.	Class Hours.	Two Hour Laboratory Periods.	Credit Hours per Week.
<i>Required.</i>				
Physics, ...	25	3	1	4
Zoölogy, ...	25	2	2	4
Botany, ...	25	1	2	3
English, ...	25	2	—	2
Military, ...	25	1	—	1
Military, ...	28	—	2	1
Total required, ...	—	—	—	15
<i>Elective.</i>				
Chemistry, ...	25	1	2	3
French, ...	25 or 28	3	—	3
German, ...	25 or 28	3	—	3
Drawing, ...	25	—	3	3
Animal husbandry, ...	25	2	1	3
Rural engineering, ...	25	—	2	2

Minimum credit for first term, 18.

Maximum credit for first term, 21.

SOPHOMORE YEAR — *Concluded.*

SECOND TERM.

SUBJECT.	Course Number.	Class Hours.	Two Hour Laboratory Periods.	Credit Hours per Week.
<i>Required.</i>				
Physics, ...	26	2	1	3
Agricultural economics, ...	26	5	—	5
English, ...	26	2	—	2
Military, ...	26	1	—	1
Military, ...	29	—	2	1
Total required, ...	—	—	—	12
<i>Elective.</i>				
Chemistry, ...	26	1	2	3
French, ...	26 or 29	3	—	3
German, ...	26 or 29	3	—	3
Mathematics, ...	26	2	—	2
Drawing, ...	26	—	3	3
Entomology, ...	26	3	—	3
Animal husbandry, ...	26	2	1	3
Rural engineering, ...	26	—	2	2
Botany, ...	26	1	2	3
Economic sociology, ...	26	5	—	5

Minimum credit for second term, 18.

Maximum credit for second term, 20.

THIRD TERM.

<i>Required.</i>				
Rural sociology, ...	27	3	—	3
Agronomy, ...	27	4	1	5
English, ...	27	2	—	2
Military, ...	27	1	—	1
Military, ...	30	—	2	1
Physical education, ¹	26	—	1	1
Total required, ...	—	—	—	13
<i>Elective.</i>				
Chemistry, ...	27	1	4	5
Chemistry, ...	30	3	2	5
French, ...	27 or 30	3	—	3
German, ...	27 or 30	3	—	3
Mathematics, ...	27	—	3	3
Drawing, ...	27	—	3	3
Entomology, ...	27	—	2	2
Geology, ...	27	3	2	5
Physics, ...	27	4	1	5
Horticulture, ...	27	2	1	3
Zoology, ...	27	1	2	3

Minimum credit for third term, 19.

Maximum credit for third term, 22.

¹ Credit for Physical Education 2 and 3 given in third term.

MAJORS: JUNIOR AND SENIOR YEARS.

GENERAL STATEMENT.

A major consists of 45 credit hours of correlated work, to be arranged by the student and an instructor called the adviser.

The list of courses found under each major on subsequent pages should not be considered as necessarily a rigid program to be followed. The heads of departments have suggested this series of courses as the best for the average man majoring in their departments. Advisers may, however, make modifications to suit the particular needs of the student, provided these modifications conform precisely to the class schedule as published for the year.

RULES GOVERNING MAJORS.

RULE 1. *Election.* — Each student, before the first term of his junior year, shall elect a major subject from the list of majors given below; and this major shall consist of 45 credit hours of correlated work.

RULE 2. *Minimum Credits.* — The minimum number of credits for graduation shall be 237 credit hours, inclusive of military drill and physical education.

RULE 3. *Maximum Credits.* — The maximum number of credits for any term of the junior or senior year shall be 22; the minimum shall be 19.

RULE 4. *Humanities and Rural Social Science.* — A minimum of 18 credit hours in the Divisions of the Humanities and Rural Social Science will be required of all students during their junior and senior years, with the following restriction: that a minimum of 5 credit hours will be required in each of the divisions.

RULE 5. *Advisers.* — The work of each junior and senior will be under the immediate supervision of an instructor designated as major adviser. Ordinarily, the major adviser will be the head of the department in which the student intends to elect his major. Each student should consult with the adviser as soon as possible. The adviser has full authority to prescribe the student's work up to 45 hours. It is understood, however, that so far as practicable the individual needs of the student will be recognized. It is also hoped and expected that students will be disposed to seek the counsel of the adviser with respect to the remaining courses required for graduation.

RULE 6. *Free Electives.* — Each student during his junior and senior years is required to take 45 hours in his major and also 18 hours in the Divisions of the Humanities and Rural Social Science, making a total of 63 hours (but see Rule 4). He is allowed free choice of courses to complete his required hours.

RULE 7. *Registration.* — No junior or senior shall register until his major course of study is approved by his adviser.

(1) Course cards for recording the election of majors will be issued from the registrar's office three weeks before the close of each term.

(2) This card must be submitted by each student to his major adviser, who will lay out the course for the succeeding term and countersign the card.

(3) Each course card must be filled out, giving the name of student, his college address, the name of parent or guardian, and the student's home address. When the major courses have been entered on this card, and the hours

of free elections added by the student, the card must be returned to the registrar one week before the beginning of the final examination period.

RULE 8. *Changes.* — Applications for changes may be made to the dean in writing at any time; when approved by him and by the committee on scholarship, they become operative at the beginning of the term following, provided that no change in the selection of a major may be made by any student after registration day of his senior year.

AGRICULTURE. (Major.)
Professor JAMES A. FOORD, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy, ...	50 I.	5	I.	Animal Husbandry 25, . . 3		Agronomy 50, ... 5		Animal Husbandry 75, . . 3	
Agronomy, ...	76 III.	5		Rural Engineering 25, . . 2		Dairying 50, ... 5		Rural Engineering 75, . . 5	
Animal Husbandry, ...	51 III.	3						Farm Management 75, . . 3	
Animal Husbandry, ...	75 I.	3	II.	Mathematics 26, ... 2				Animal Husbandry 76, . . 3	
Animal Husbandry, ...	76 II.	3		Animal Husbandry 26, . . 3					
Dairying, ...	50 I.	5		Rural Engineering 26, . . 2					
Farm Management, ...	75 II.	3	III.	Chemistry 30, ... 5		Microbiology 50, ... 5		Agronomy 76, ... 5	
Farm Management, ...	76 III.	5		Mathematics 27, ... 3		Animal Husbandry 51, . . 3		Farm Management 76, . . 5	
Microbiology, ...	50 I.	5		Horticulture 27, ... 3					
or									
Microbiology, ...	50 III.	5	IV.						
Rural Engineering, ...	75 I.	5							
		42							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Animal Husbandry 25 and 26, Rural Engineering (shop work) 25 and 26, Chemistry 30 or Chemistry 6, Freshman, Mathematics 26 and 27, and Horticulture 27.

ADDITIONAL INFORMATION. — Dairying 75, Pomology 50 and 51, Rural Engineering 78, and Veterinary 51 and 78 are suggested as additional courses for the student fitting himself for general agriculture.

AGRONOMY. (Major.)

Professor ARTHUR B. BEAUMONT, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy, ...	50 I.	5	I.	Chemistry 25, ...	3	Agronomy 50, ...	5	Agronomy 75, ...	5
Agronomy, ...	51 III.	5		German 25 or 28, ...	3	Chemistry 51, ...	8	Animal Husbandry 75, ...	3
Agronomy, ...	75 I.	5							
Agronomy, ...	77 II.	5	II.	Botany 26, ...	3	Chemistry 52, ...	8	Agronomy 77, ...	5
Animal Husbandry, ...	75 I.	3		Chemistry 26, ...	3				
Chemistry, ...	51 I.	8		German 26 or 29, ...	3				
				Mathematics 26, ...	2				
Chemistry, ...	52 II.	8	III.	German 27 or 30, ...	3	Agronomy 51, ...	5	Farm Management 76, ...	5
Farm Management, ...	76 III.	5		Mathematics 27, ...	3				
				Geology 27, ...	5				
		44	IV.						

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Chemistry 25 and 26, German 25 or 28, 26 or 29, 27 or 30, Geology 27, Botany 26.
 ADVISED. — Mathematics 26 and 27.

ANIMAL HUSBANDRY. (Major.)
Professor JOHN C. MCNUTT, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.		Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
		Credit.							
Agronomy, ...	50 I.	5	I.	Animal Husbandry 25, . 3		Agronomy 50, . . . 5		Animal Husbandry 75, . 3	
Animal Husbandry, ...	51 III.	3				Veterinary 50, . . . 5		Farm Management 75, . 3	
Animal Husbandry, ...	50 II.	1				Dairying 50, . . . 5			
Animal Husbandry, ...	52 III.	3	II.	Animal Husbandry 26, . 3		Animal Husbandry 50, . 3		Animal Husbandry 76, . 3	
Animal Husbandry, ...	75 I.	3						Animal Husbandry 78, . 3	
Animal Husbandry, ...	76 II.	3							
Animal Husbandry, ...	77 III.	3	III.	Chemistry 30, . . . 5		Animal Husbandry 51, . 3		Animal Husbandry 80, . 1	
Animal Husbandry, ...	78 II.	3				Animal Husbandry 52, . 3		Animal Husbandry 77, . 3	
Animal Husbandry, ...	80 III.	1						Farm Management 76, . 5	
Dairying, ...	50 I.	5	IV.						
Farm Management, ...	75 II.	3							
Farm Management, ...	76 III.	5							
Veterinary, ...	50 I.	5							
		43							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Animal Husbandry 25 and 26, Chemistry 30.
ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left to the student to choose.

DAIRYING. (Major.)

Professor WILLIAM P. B. LOCKWOOD, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Animal Husbandry, ...	52 III.	3	I.	Animal Husbandry 25, . 3		Dairying 50, . . . 5		Animal Husbandry 75, . 3	
Animal Husbandry, ...	75 I.	3		Rural Engineering 25, . 2		Microbiology 50, . . 5		Microbiology 82, . . 5	
Animal Husbandry, ...	76 II.	3						Farm Management 75, . 3	
Dairying, ...	50 I.	5	II.	Animal Husbandry 26, . 3		Rural Engineering 77, . 5		Animal Husbandry 76, . 3	
Dairying, ...	51 III.	5		Rural Engineering 26, . 2		Microbiology 51, . . 5		Dairying 75, . . . 5	
Dairying, ...	75 II.	5				(Prerequisite to 82.)			
Dairying, ...	76 III.	5	III.	Chemistry 30, . . . 5		Animal Husbandry 52, . 3		Dairying 76, . . . 5	
Farm Management, ...	75 II.	3				Dairying 51, . . . 5			
Microbiology, ...	50 I.	5							
Microbiology, ...	82 I.	5							
Rural Engineering, ...	77 II.	5	IV.						
		47							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Animal Husbandry 25 and 26, Rural Engineering 25 and 26, Chemistry 30.
 ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left to the student to choose.

POULTRY HUSBANDRY. (Major.)
 PROFESSOR JOHN C. GRAHAM, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Animal Husbandry, ...	51 III.	3	I.			Poultry 50,	. . . 3	Poultry 76,	. . . 5
Poultry Husbandry, ...	50 I.	3				Poultry 51,	. . . 2	Poultry 77,	. . . 5
								Pomology 50,	. . . 3
Poultry Husbandry, ...	51 I.	2	II.			Poultry 52,	. . . 3	Poultry 75,	. . . 5
Poultry Husbandry, ...	52 II.	3						Veterinary 86,	. . . 3
Poultry Husbandry, ...	53 III.	5						Poultry 55,	. . . 1-5
Poultry Husbandry, ...	55	1-5							
			III.			Poultry 53,	. . . 5		
Poultry Husbandry, ...	54 III.	2				Poultry 54,	. . . 2		
Poultry Husbandry, ...	75 II.	5				Animal Husbandry 51,	. . . 5		
Poultry Husbandry, ...	76 I.	5				Agricultural Economics 53,	5		
Agricultural Economics,	53 III.	5							
			IV.						
Poultry Husbandry, ...	77 I.	5							
Pomology, ...	50 I.	3							
Veterinary Science, ...	86 II.	3							
		45-49							

SOPHOMORE RECOMMENDATIONS. — Students intending to major in Poultry Husbandry are urged to take Zoölogy 27.
 ADVISED. — Juniors who did not take Zoölogy 27 as sophomores are strongly advised to include it in their program.

FLORICULTURE.

Associate Professor CLARK L. THAYER, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Botany, ...	50 I.	2	I.	Drawing 25, ...	 3	Floriculture 50, ...	 4	Floriculture 75, ...	 3
Botany, ...	51 II.	2				Floriculture 53, ...	 3	Horticulture 50, ...	 5
Entomology, ...	26 II.	3				Botany 50, ...	 2		
Floriculture, ...	50 I.	4	II.	Drawing 26, ...	 3	Floriculture 51, ...	 4	Floriculture 77, ...	 3
Floriculture, ...	51 II.	4		Entomology 26, ...	 3	Floriculture 54, ...	 3	Floriculture 76, ...	 3
Floriculture, ...	52 III.	4		Botany 26, ...	 3	Entomology 26, ...	 5		
Floriculture, ...	53 I.	3	III.	Drawing 27, ...	 3	Floriculture 52, ...	 4	Floriculture 80, ...	 3
Floriculture, ...	54 II.	3		Entomology 27, ...	 2	Floriculture 78, ...	 3	Horticulture 51, ...	 5
Floriculture, ...	75 I.	3		Horticulture 27, ...	 3				
Floriculture, ...	76 II.	3	IV.						
Floriculture, ...	77 II.	3							
Floriculture, ...	78 III.	3							
Floriculture, ...	80 III.	3							
Horticulture, ...	50 I.	5							
Horticulture, ...	51 III.	5							
		50							

SOPHOMORE ELECTIVE PREREQUISITES. — Drawing 25, 26 and 27, Entomology 26 and 27, Botany 26 and Horticulture 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left to the student to choose. Horticulture 50 and 51 will be taken by seniors. ADVISED. — The department advises all students who major in this subject to take Botany 78, Entomology 50 and Landscape Gardening 75.

FORESTRY. (Major.)
Professor WILLIAM D. CLARK, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Botany, ...	50 I.	2	I.	Drawing 25, ...	3	Forestry 50, ...	3	Forestry 75, ...	5
Botany, ...	50 II.	2		Rural Engineering 25, ...	2	Landscape Gardening 50, ...	5		
Entomology, ...	75 III.	4				Horticulture 50, ...	5		
						Botany 50, ...	2		
Forestry, ...	50 I.	3	II.	Drawing 26, ...	3	Forestry 51, ...	3		
Forestry, ...	51 II.	3		Mathematics 26, ...	2	Botany 51, ...	2		
Forestry, ...	53 III.	3		Entomology 26, ...	3	Landscape Gardening 51, ...	4		
Forestry, ...	54 IV.	5		Botany 26, ...	3				
Forestry, ...	75 I.	5	III.	Drawing 27, ...	3	Forestry 53, ...	3	Forestry 78, ...	3
Forestry, ...	78 III.	3		Mathematics 27, ...	2	Horticulture 51, ...	5		
Horticulture, ...	50 I.	5		Entomology 27, ...	3	Entomology 75, ...	4		
				Horticulture 27, ...	3				
Horticulture, ...	51 III.	5	IV.			Landscape Gardening 53, ...	5		
Landscape Gardening, ...	50 I.	5				Forestry 54, ...	5		
Landscape Gardening, ...	51 II.	4							
		49							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Drawing 25, 26 and 27, Rural Engineering 25, Mathematics 26 and 27, Entomology 26 and 27, Botany 26, Horticulture 27.

ADDITIONAL INFORMATION. — Substitutions according to individual needs may be made in conference with the adviser.

LANDSCAPE GARDENING. (Major.)

Professor FRANK A. WAUGH, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.		Term.	Sophomore.		Credit.	Junior.	Credit.	Senior.	Credit.
		Credit.								
Floriculture, ...	78 III.	3	I.	Drawing 25,		. 3	Landscape Gardening 50, . . 5		Landscape Gardening 75, . . 3	
Horticulture, ...	50 I.	5					Horticulture 50, ... 5		Landscape Gardening 53, (when not taken in Term IV.), ... 5	
Horticulture, ...	51 III.	5								
Landscape Gardening, ...	50 I.	5								
Landscape Gardening, ...	51 II.	4	II.	Drawing 26,		. 3	Landscape Gardening 51, . . 4		Landscape Gardening 76, . . 4	
Landscape Gardening, ...	52 III.	5		Mathematics 26,		. 2				
Landscape Gardening, ...	53 IV.	5		Entomology 26,		. 3				
Landscape Gardening, ...	75 I.	3	III.	Drawing 27,		. 3	Landscape Gardening 52, . . 5		Landscape Gardening 78 or 79,	3
Landscape Gardening, ...	76 II.	4		Mathematics 27,		. 3	Horticulture 51, ... 5		Landscape Gardening 77, . . 4	
Landscape Gardening, ...	77 III.	4		Horticulture 27,		. 3	Landscape Gardening 78 or 79, ... 3		Floriculture 78, ... 3	
Landscape Gardening, ...	78 III.	3	IV.				Landscape Gardening 53, . . 5			
or Landscape Gardening, ...	79 III.	3								
		49								

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Drawing 25, 26 and 27, Mathematics 26 and 27, Horticulture 27.
 ADDITIONAL INFORMATION. — Modifications may be permitted when they appear advisable.

POMOLOGY. (Major.)
Professor FRED C. SEARS, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.		Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy, ... Agronomy, ... Horticultural Manufactures, ...	77 II.	5	I.				Pomology 50, ...	3	Pomology 75, ...	3
	75 I.	5					Agronomy 75, ...		Pomology 77, ...	
	75 I.	5							Pomology 80, ...	
Pomology, ... Farm Management, ... Horticultural Manufactures, ...	50 I.	3	II.				Pomology 51, ...	3	Pomology 76, ...	3
	75 II.	3					Farm Management 75, ...		Pomology 81, ...	
	76 II.	3							Agronomy 77, ...	
Pomology, ... Pomology, ... Pomology, ... Rural Engineering, ... Agricultural Economics, ...	51 II.	3	III.		Horticulture 27, ...	3	Pomology 52, ...	3	Pomology 78, ...	3
	52 III.	3								
	75 I.	3								
	78 III.	5								
	53 III.	5								
Pomology, ... Pomology, ... Pomology, ... Pomology, ... Pomology, ...	76 II.	43	IV.				Pomology 53, ...	5	Pomology 82, ...	1
	77 I.									
	78 III.									
	80 I.									
	81 II.									
	82 III.									

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Horticulture 27.

ADVISED. — Rural Engineering 26, Entomology 26 and 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left to the student to choose.

VEGETABLE GARDENING. (Major.)

Associate Professor A. L. DACY, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agromony, ...	75 I.	5	I.			Vegetable Gardening 51, . . 3		Vegetable Gardening 75, . . 5	
Agromony, ...	77 II.	5				Botany 50, ... 2		Agromony 75, ... 5	
Botany, ...	50 I.	2						Vegetable Gardening 78, . . 1	
Botany, ...	51 II.	2							
Vegetable Gardening, . .	51 I.	3	II.	Botany 26, ...	. . . 3	Vegetable Gardening 52, . . 3		Vegetable Gardening 76, . . 5	
Vegetable Gardening, . .	52 II.	3				Botany 51, ... 2		Vegetable Gardening 79, . . 1	
Vegetable Gardening, . .	53 III.	3						Agromony 77, ... 5	
Vegetable Gardening, . .	54 IV.	5	III.	Horticulture 27, ...	. . . 3	Vegetable Gardening 53, . . 3		Vegetable Gardening 77, . . 5	
Vegetable Gardening, . .	75 I.	5						Vegetable Gardening 80, . . 1	
Vegetable Gardening, . .	76 II.	5	IV.			Vegetable Gardening 54, . . 5			
Vegetable Gardening, . .	77 III.	5							
Vegetable Gardening, . .	78	1							
Vegetable Gardening, . .	79	1							
Vegetable Gardening, . .	80	1							
		46							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Botany 26, Horticulture 27.

ADVISED. — Rural Engineering 26, Entomology 26 and 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left to the student to choose.

ECONOMIC BOTANY. (Major.)
Professor A. VINCENT OSMUN, *Adviser*.
[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Botany, ...	52 I.	3	I.	Chemistry 25, ...	 3	Botany 52, ...	 3	Botany 75, ...	 5
Botany, ...	53 II.	3		German 25 or 26, ...	 3	Botany 55, ...	 3	Botany 78, ...	 5
Botany, ...	54 III.	3				Chemistry 51, ...	 8	Botany 86, ...	 1
Botany, ...	55 I.	3							
Botany, ...	56 II.	3							
Botany, ...	75 I.	5	II.	Chemistry 26, ...	 3	Botany 53, ...	 3	Botany 76, ...	 5
Botany, ...	76 II.	5		German 26 or 29, ...	 3	Botany 56, ...	 3	Botany 79, ...	 5
Botany, ...	77 III.	5		Botany 26, ...	 3			Botany 82, ...	 3
Botany, ...	78 I.	5						Botany 87, ...	 1
Botany, ...	79 II.	5							
Botany, ...	80 III.	5							
Botany, ...	82 II.	3	III.	German 27 or 30, ...	 3	Botany 54, ...	 3	Botany 77, ...	 5
Botany, ...	83 III.	3						Botany 80, ...	 5
Botany, ...	86 I.	1						Botany 83, ...	 3
Botany, ...	87 II.	1						Botany 88, ...	 1
Botany, ...	88 III.	1							
Botany, ...	51 I.	8							
Chemistry, ...		62							
			IV.						

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — German 25 or 28, 26 or 29, 27 or 30, Botany 26.
ADVISED. — Chemistry 25 and 26.
ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left to the student to choose.
Selection of 45 credits of the above (Pathology 75, 76 and 77, Physiology 78, 79 and 80).

AGRICULTURAL CHEMISTRY. (Major.)

Professor CHARLES A. PETERS, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

Course.		Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.	
Chemistry, ...		51 I.	8	I.	Chemistry 25, . . .	. . . 3	Chemistry 51, . . .	. . . 8	Chemistry 76, . . .	. . . 5	
Chemistry, ...		52 II.	8		German 25 or 26, . . .	. . . 3	Chemistry 60, . . .	. . . 3	Chemistry 80, . . .	. . . 5	
Chemistry, ...		62 III.	5								
Chemistry, ...		65 III.	5	II.	Chemistry 26, . . .	. . . 3	Chemistry 52, . . .	. . . 8	Chemistry 77, . . .	. . . 3	
Chemistry, ...		76 I.	5		German 26 or 29, . . .	. . . 3	Chemistry 61, . . .	. . . 3	Chemistry 90, 92, 94, . . .	. . . 3	
Chemistry, ...		77 II.	5								
Chemistry, ...		80 I.	5								
Chemistry, ...		87 III.	3								
Chemistry, ...		90 II.	3 ¹								
Chemistry, ...		92 II.									
Chemistry, ...		94 II.									
Chemistry, ...		91 III.	5	III.	Chemistry 27, . . .	. . . 5	Chemistry 62, . . .	. . . 5	Chemistry 91, 93, 95, . . .	. . . 5	
Chemistry, ...		93 II.			German 27 or 30, . . .	. . . 3	Chemistry 65, . . .	. . . 5	Chemistry 87, . . .	. . . 3	
Chemistry, ...		95 III.									
			50 ²	IV.							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Chemistry 25, 26 and 27.

ADVISED. — German 25 or 28, 26 or 29, 27 or 30, Entomology 26 and 27.

ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left for the student to choose.

¹ Courses 90, 92, 94 may be changed from 3 credits to an option of 3 or 5 credits. Students will select one course from groups 90, 92, 94, and 91, 93, 95 respectively.² Only 45 credits required.

ECONOMIC ENTOMOLOGY. (Major.)

Professor HENRY T. FERNALD, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Botany, or Botany, Entomology, Entomology,	50 I. 52 I. 50 I. 51 II.	3 3 3 3	I.	French 25 or 28, or German 25 or 28, Chemistry 25, . . .	. . . 3 . . . 3 . . . 3	Entomology 50, . Entomology 53, Botany 50 or 52, Zoology 50 or 53, or Chemistry 51, . . .	. . . 3 . . . 5 . . . 3 . . . 3 . . . 8	Entomology 76, Vegetable gardening 50, Horticulture 50, . . .	. . . 5 . . . 3 . . . 5
Entomology, Entomology, Entomology, Entomology, Entomology,	53 I. 54 II. 55 III. 75 III. 76 I.	5 3 3 4 5	II.	French 26 or 29, or German 26 or 29, Entomology 26, . . . Botany 26,	. . . 3 . . . 3 . . . 3 . . . 3	Entomology 51, Entomology 54, Microbiology 50,	. . . 3 . . . 3 . . . 5	Entomology 77, Entomology 90,	. . . 3 . . . 3
Entomology, Entomology, Entomology,	77 II. 78 III. 90 II.	3 4 3	III.	French 27 or 30, or German 27 or 30, Entomology 27, . . .	. . . 3 . . . 3 . . . 2	Entomology 55, Entomology 75, Horticulture 27, Pomology 79, . . .	. . . 3 . . . 4 . . . 3 . . . 3	Entomology 78, Horticulture 51, Pomology 78, . . .	. . . 4 . . . 5 . . . 3
Zoölogy, or Zoölogy, or Chemistry, . . .	50 I. 53 I. 51 I.	3 3 8	IV.						
		42 or 47							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Entomology 25 and 27, Botany 26.

ADVISED. — French or German 25 to 27 or 28 to 30, Chemistry 25; the other subjects (except Entomology) in the last three columns above are merely suggested as desirable to choose from.

RURAL JOURNALISM. (Major.)

Associate Professor ROBERT W. NEAL, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Rural Journalism, ...	50 I.	3	I.			Journalism 50, ...	3	Journalism 77, ...	3
Rural Journalism, ...	51 II.	3				Journalism 53, ...	3	Journalism 80, ...	4 (5)
Rural Journalism, ...	52 III.	3				Agricultural Economics 51, 5	5		
Two out of three: —									
Rural Journalism, ...	53 I.	3	II.	Economics and Sociology 26, 5		Journalism 51, ...	3	Journalism 78, ...	3
Rural Journalism, ...	54 II.	3				Journalism 54, ...	3	Journalism 81, ...	4 (5)
Rural Journalism, ...	55 III.	3				Economics and Sociology 51, 5	5		
Two out of three: —									
Rural Journalism, ...	77 I.	3	III.			Journalism 55, ...	3	Journalism 79, ...	3
Rural Journalism, ...	78 II.	3				Journalism 52, ...	3	Journalism 82, ...	4 (5)
Rural Journalism, ...	79 III.	3							
One from: —	90 II.								
Entomology, ...									
or									
Animal Husbandry, ...	51 III.	3							
Landscape, ...	75 I.								
Chemistry, ...	87 III.								
All: —									
Rural Journalism, ...	80 I.	4 (5)							
Rural Journalism, ...	81 II.	4 (5)							
Rural Journalism, ...	82 III.	4 (5)							
Rural Sociology, ...	78 II.	5	IV.						
Agricultural Economics, ...	51 III.	5							
Economics and Sociology, ...	51 I.	5							
		45-47							

SOPHOMORE PREREQUISITES. — All sophomore English.

SOPHOMORE RECOMMENDATIONS. — French or German; Drawing 25. For agricultural journalism especially: Animal Husbandry 25, 26, Chemistry 30, Entomology 26, 27.

AGRICULTURAL ECONOMICS. (Major.)
 PROFESSOR ALEXANDER E. CANCE, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics, ...	50 I.	5	I.			Agricultural Economics 50, 5 Economic Sociology 51, . 5		Agricultural Economics 77, 5	
Agricultural Economics, ...	52 II.	5							
Agricultural Economics, ...	53 III.	5							
Agricultural Economics, ...	78 III.	3							
Agricultural Economics, ...	76 II.	5	II.			Agricultural Economics 52, 5 Rural Sociology 51, . . 3 Economic Sociology 50, . 5		Agricultural Economics 76, 5 Rural Sociology 78, . . 5	
or Agricultural Economics, ...	77 I.								
Economic Sociology, ...	51 I.	5							
Economic Sociology, ...	50 II.	5	III.			Rural Sociology 52, . . 3 Agricultural Economics 53, 5		Farm Management 76, . 5 Agricultural Economics 78, 3	
Farm Management, ...	76 III.	5							
Rural Sociology, ...	51 II.	3							
or Rural Sociology, ...	52 III.		IV.						
Rural Sociology, ...	78 II.	5							
		46							

ADDITIONAL INFORMATION. — The sophomore electives are left to the student to choose. Animal husbandry is suggested for terms I. and II., and Economic Sociology for term III.

AGRICULTURAL EDUCATION. (Major.)
Professor WILLIAM R. HART, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agricultural Education (Educational Psychology).	50 I.	5	I.	Animal Husbandry 25,	. 3	Agricultural Education 50,	5	Agricultural Education 75,	3
Agricultural Education (Principles of Teaching).	51 II.	5		Rural Engineering 25,	. 2	Agricultural Education 76,	3	Agricultural Education 80,	1-5
Agricultural Education (History and Philosophy).	52 III.	5						Agricultural Education 76,	3
Agricultural Education (Secondary Education).	75 I.	3	II.						
Agricultural Education (Methods in Vocational Agriculture).	76 I.	3		Entomology 26,	. 3	Agricultural Education 51,	5	Agricultural Education 76,	3
Agricultural Education (Methods in Vocational Agriculture).	76 II.	3		Rural Engineering 26,	. 2	Agricultural Education 76,	3	Agricultural Education 77,	5
Agricultural Education (Methods in Vocational Agriculture).	76 III.	3		Animal Husbandry 26,	. 3			Agricultural Education 80,	1-5
Agricultural Education (county agent work).	77 II.	5	III.						
Agricultural Education (county agent work).	77 III.	5		Entomology 27,	. 3	Agricultural Education 52,	5	Agricultural Education 76,	3
Agricultural Education (apprentice teaching).	80 I.	1-5		Horticulture 27,	. 3	Agricultural Education 76,	3	Agricultural Education 77,	5
Agricultural Education (apprentice teaching).	80 II.	1-5	IV.			Agricultural Education 77,	5	Agricultural Education 80,	1-5
Agricultural Education (apprentice teaching).	80 III.	1-5							
Agricultural Education (apprentice teaching).	80 IV.	1-5							

Courses available in the Summer School: Agricultural Education 51, 75, 76, 80, and special courses leading to positions as supervisors and directors of agricultural teaching and to college positions in Agricultural Education.

ADDITIONAL INFORMATION. — Courses 50, 51, 76 and 80 or their equivalents are required of all candidates for teaching; credits vary from 14 to 18. Courses 51 and 77 are required of all candidates for county agent work. Students who are intending to teach are recommended to take as many of the sophomore electives listed above as possible in the sophomore year. Programs for juniors and seniors are planned on the basis of individual needs, with a view to the most desirable preparation for the attainment of the student's aim. Some of the aims for which programs are planned are as follows: teaching vocational agriculture; teaching non-agricultural subjects in vocational agricultural schools and departments; teaching agriculture in high schools not of the vocational type; county agent work and Junior Extension work; directing physical education and county Y. M. C. A. work; rural school supervision and rural leadership; positions as supervisors and directors of agricultural teaching; and college positions in Agricultural Education.

RURAL SOCIOLOGY. (Major.)

Professor JOHN PHELAN, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics,	50 I.	5	I.			Agricultural Economics 50,	5	Rural Sociology 75,	3
Agricultural Economics,	52 II.	5				Rural Sociology 50,	3	Economics and Sociology 75,	5
Economics and Sociology,	54 II.	5							
Economics and Sociology,	75 I.	5							
Economic Sociology,	76 III.	5	II.			Rural Sociology 51,	3	Rural Sociology 77,	3
Rural Journalism,	55 III.	3				Agricultural Economics 52,	5	Rural Sociology 78,	5
						Agricultural Education 52,	5		
						Economic Sociology 51,	5		
Rural Sociology,	50 I.	3	III.			Rural Journalism 55,	3	Economic Sociology 76,	5
Rural Sociology,	52 III.	3				Rural Sociology 52,	3		
Rural Sociology,	51 II.	3							
Rural Sociology,	77 II.	3	IV.						
Rural Sociology,	75 I.	3							
Agricultural Education,	52 II.	5							
or									
Rural Sociology,	78 II.								
		48							

ADDITIONAL INFORMATION. — The sophomore electives allowed are left to the student to choose.

DESCRIPTION OF COURSES

DESCRIPTION OF COURSES.

DIVISION OF AGRICULTURE.

Professor FOORD.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

AGRICULTURE AND HORTICULTURE. Freshmen. This course continuing through the year constitutes the required elementary work dealing with the foundations of the subjects of live stock and the crops of the field, orchard and the garden. Several departments collaborate in giving the work; three credits each term are assigned to this course. For a description of the work see —

Agronomy 1, I.
Animal Husbandry 1, II.
Horticulture, 1, I.
Poultry Husbandry 1, II.

Agronomy.

Professor BEAUMONT, Assistant Professor COOPER, Mr. MERKLE, Mr. THAYER, Mr. PURINGTON, Mr. MALLOREY.

The courses in agronomy are designed to give the student fundamental knowledge concerning the soil and the principal products of the field. The basic course in soils is required of all students. The electives purpose to meet the needs of those specializing in soils and field crops and other specialized fields including both pure and applied science.

The laboratories for soils and fertilizers include one for elementary work, supplied with locker equipment for 200 students, and one for advanced work, accommodating 80 students. These laboratories are equipped with steam and electric ovens, balances, centrifuge, microscopes and other apparatus necessary for a study of soils and fertilizers. Storerooms, stock rooms, and balance rooms are located convenient to the laboratories. There is also a workroom attached, equipped with power machinery for grinding soils, fodders and the like.

The crops' laboratories include one for seed study, having a locker equipment for 50 students, and a laboratory for the study of cereals, forage crops, roots, etc., with lockers for 64 students. The equipment of these laboratories includes steam ovens, constant temperature electric ovens, ovens for seed germination, Brown-Duval moisture apparatus, balances, microscopes, and collections of seeds, grasses, tubers, weeds, etc. A balance room, root cellar and two storerooms, one of which is mouse-proof, are also used for crop work.

A modern steam-heated greenhouse 25 by 35 feet, used for work in soils and crops, is a valuable part of the equipment. Near the greenhouse is a crop

garden on which different varieties of corn, grasses, clovers, etc., are grown for demonstration purposes, and as a source of material for class work. In addition, the general college farm of 250 acres is used for field study in soils and crops, and as a source of material.

Required Courses.

1. **I. AGRONOMY.** — Freshmen. Given as part of the freshman agriculture and horticulture. This course aims, by actual contact with the plants and the plant products, to make the students familiar with the common field, garden and orchard crops of Massachusetts.

Assistant Professor COOPER and the DEPARTMENT.

27. **III. SOILS AND FERTILIZERS.** — Sophomores. A study of soils and their properties, soil management, methods of soil improvement and maintenance of fertility, including the use of farm manures, commercial fertilizers and soil amendments.

4 class hours.

1 2-hour laboratory period, credit, 5.

Professor BEAUMONT and the DEPARTMENT.

Prerequisites, Freshman-required Chemistry.

Elective Courses.

50. **I. FIELD AND FORAGE CROPS.** — For juniors; seniors may elect. History, classification and production of corn and of those grasses, legumes, root and tuber crops suited to New England conditions. Crops of less importance in New England are briefly considered. The work includes lecture, laboratory and field study.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Assistant Professor COOPER and the DEPARTMENT.

Prerequisites, Agronomy 27, Botany 3.

51. **III. ADVANCED FIELD CROPS.** — For juniors; seniors may elect. Study of the cereals and other field crops not taken up or only briefly considered in Course 50. General problems of crop production are also considered, and the work is not entirely confined to New England conditions. The laboratory work includes a study of the cereals, the quality of seeds, grains and crop products, crop problems and field work with such crops as are available.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Assistant Professor COOPER and the DEPARTMENT.

Prerequisite, Agronomy 50.

75. **I. ADVANCED SOILS.** — For seniors; juniors may elect. A field, lecture and laboratory course on soils and their adaptability to different uses. The field work consists of a detailed study of soil textures, natural and spontaneous vegetation and other factors which indicate the fertility and adaptation of the soil; accompanied by a laboratory study of the physical properties of the soils sampled.

2 class hours.

1 4-hour and 1 2-hour laboratory period, credit, 5.

Professor BEAUMONT and Mr. MERKLE.

Prerequisite, Agronomy 27. Advised, Geology, 27.

76. **III. DRAINAGE AND IRRIGATION.** — For seniors; juniors may elect. A field and lecture course on soil improvement by drainage and irrigation, with special reference to problems of this nature as faced by Massachusetts farmers. To accompany Rural Engineering 79, **III.**

1 class hour.

1 2-hour laboratory period, credit, 2.

Mr. MERKLE.

Prerequisites, Mathematics 26 and 27, Agronomy 27.

77. **II. MANURES AND FERTILIZERS.** — Seniors. An advanced course, giving a general discussion of the different theories which have been held relative to the functions and importance of manures and fertilizers, and leading up to the views at present accepted. Considerable attention is devoted to consideration of the experimental work which has been done, and which is now in progress. The laboratory work consists of a study of fertilizers, fertilizer mixtures, limes and culture work.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Professor BEAUMONT and Mr. MERKLE.

Prerequisite, Agronomy 27. Advised, Chemistry 27.

78. **II. BREEDING OF FIELD CROPS.** — Seniors. This course deals with the improvement, by selection and breeding, of the crops studied in Courses 50 and 51.

2 class hours.

1 2-hour laboratory period, credit, 3.

Assistant Professor COOPER.

Prerequisite, Agronomy 51.

Animal Husbandry.

Professor McNUTT, Assistant Professor RICE, Mr. HOLDEN.

It is the purpose of this department to give students a broad, comprehensive knowledge of the subject of animal husbandry. The courses are arranged so that a student first studies the breeds of live stock and types and market classes of live stock. These courses are followed with courses in judging, breeding, feeding and management, so that the student has an opportunity to secure a thorough training in animal husbandry.

The department is equipped with an excellent laboratory, Grinnell Arena, which has a seating capacity of 180, and which is fully adapted to the requirements. There are upwards of 125 head of dairy cattle of various ages available for classroom work; among these are included superior representatives of the Jersey, Guernsey, Ayrshire and Holstein, of the best breeding and individuality. Considerable numbers of pure-bred Berkshire and Chester White pigs are maintained. The college possesses pure-bred Percherons besides several work teams of different types, which are available for classroom purposes. A set of plaster of Paris models of individuals of foreign and domestic breeds of horses, cattle, sheep and swine, and a collection of the different foodstuffs available for the use of the New England farmer, are included in the equipment for this work. An excellent set of upward of 250 lantern slides portraying the leading prize-winning, producing and breeding animals of the leading breeds, — horses, cattle, sheep and swine, — belongs to this department, and is regularly used in instructional work. This equipment is being added to from time to time as funds are available.

Required Course.

1. **II. ANIMAL HUSBANDRY.**— Freshmen. Given as part of the freshman agriculture and horticulture. This course acquaints the student with the foundations of the live-stock industry. In the lectures the types and market classes of farm animals, and their uses, are considered; in the laboratory period elementary judging practice familiarizes the student with animals of the various types.

1 class hour.

1 2-hour laboratory period, credit, 2.

Mr. HOLDEN.

Elective Courses.

25. **I. BREEDS AND TYPES OF LIVE STOCK.**— Sophomores. A course covering the origin, history, development and characteristics of the different breeds of horses, cattle, sheep and swine. Textbook, Plumb's "Breeds and Types of Farm Animals."

2 lectures.

1 2-hour laboratory period, credit, 3.

Assistant Professor RICE and Mr. HOLDEN.

26. **II. BREEDS AND TYPES OF LIVE STOCK.**— Sophomores. Continuation of Course 25.

2 lectures.

1 2-hour laboratory period, credit, 3.

Assistant Professor RICE and Mr. HOLDEN.

Prerequisite, Animal Husbandry 25.

50. **II. LIVE-STOCK MANAGEMENT.**— For juniors; seniors may elect. The work of this course consists of laboratory work by the individual students in the handling of live stock; with horses, such work as halter breaking, harnessing, casting and fitting for show will be done; similarly, the practical handling of cattle, sheep and swine will be fully treated. Special study is given to halter making, splicing, hitches, knots and all rope work.

2 lectures.

1 2-hour laboratory period, credit, 3.

Professor McNUTT.

Prerequisites, Animal Husbandry 25 and 26.

51. **III. PRINCIPLES OF BREEDING.**— For juniors; seniors may elect. This course is designed to familiarize the student with the problems that are involved in animal improvement; to acquaint him with the facts which are already established; to scrutinize prevailing theories; and to indicate the lines and methods of further work. Some of the subjects studied are: variations, their causes and heritability; DeVrie's theory of mutations; the inheritance of acquired characters; the pure line; Mendelian law; the making of new types; the determination of sex; applications to human heredity. A few periods at the end of the course are devoted especially to the application of principles in live-stock improvement. "Genetics," by Herbert E. Walter. Supplementary reading.

3 class hours.

Credit, 3.

Assistant Professor RICE.

Prerequisite, Zoölogy 25.

52. **III. ADVANCED STOCK JUDGING.** — For juniors; seniors may elect. This course is designed to equip animal husbandry students in the judging of classes of different types of live stock; to strengthen them in the selection of superior sires; and equip them for stock judging at fairs. Visits will be made to the best herds for the various breeds of stock in the State. Judging teams to represent the college will be selected from this class.

1 2-hour and 1 4-hour laboratory period, credit, 3.

Professor McNUTT.

Prerequisite, Animal Husbandry 50.

75. **I. FEEDING AND MANAGEMENT.** — For seniors; juniors may elect. A study of the principles of animal nutrition; of the composition and qualities of feeding materials. Textbook, Henry's "Feeds and Feeding."

3 class hours.

Credit, 3.

Assistant Professor RICE.

Prerequisite, Chemistry 30 or 51.

76. **II. FEEDING AND MANAGEMENT.** — For seniors; juniors may elect. A study of the feeding, care and management of dairy cattle from birth to maturity, with especial attention to economic production. Textbook, Henry's "Feeds and Feeding."

3 class hours.

Credit, 3.

Assistant Professor RICE.

Prerequisite, Chemistry 30 or 51.

77. **III. FEEDING AND MANAGEMENT.** — For seniors; juniors may elect. A continuation of Courses 75 and 76, dealing in a similar manner with horses, sheep, beef cattle and swine.

3 class hours.

Credit, 3.

Assistant Professor RICE.

Prerequisite, Animal Husbandry 75.

78. **II. HERD AND STUD-BOOK STUDY.** — For seniors; juniors may elect. An advanced course in the study of the breeds of live stock, familiarizing the student with the detailed history of the breed, the most productive sires and dams of the various breeds, and the successful lines and methods of breeding.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Professor McNUTT.

Prerequisite, Animal Husbandry 75.

80. **III. SEMINAR.** — For seniors majoring in animal husbandry only. Advanced study upon questions pertaining to live stock and live-stock production. Each student electing this work will choose some particular line of work in which he is specially interested, and will pursue study in this subject by reading, compilation and research. There will be no regular lecture period, but seminars will be held. A satisfactory report of the results must be presented in a thesis.

1 2-hour laboratory period, credit, 1.

Professor McNUTT.

Dairying.

Professor LOCKWOOD, Associate Professor JUDKINS, Assistant Professor YAXIS, Mr. VAN HORN, Mr. WHEELER.

The dairy manufactures building is new, well lighted and of sanitary construction. It is designed and equipped especially for teaching dairy manufactures. The equipment includes all kinds of machinery that are considered essential to the proper handling of milk and the making of cream, butter, ice cream and soft cheeses.

Course 77 is given for students who wish to get a general idea of dairy work and manufacturing processes. Part of the courses are arranged to give instruction in general dairy work as associated with Massachusetts agriculture; part are arranged to give to a smaller group of students more complete work in manufactures.

Elective Courses.

50. **I. MILK AND MILK COMPOSITION.** — For juniors; seniors may elect. The development of the dairy business in the United States; the composition, secretion and general characteristics of milk; contamination and fermentation; the study of analysis of milk products by use of the Babcock test for fat, tests for acidity and adulteration, and ordinary preservatives; moisture tests for butter; methods for testing herds and developing them to higher efficiency; problems.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Professor LOCKWOOD and Mr. WHEELER.

51. **III. BUTTER MAKING.** — For juniors; seniors may elect. A study of separators and cream separation; handling milk and cream for butter making; preparation of starters, and ripening cream; churning; markets and their requirements; marketing, scoring and judging butter; management; problems; dairy machinery and care thereof.

2 class hours.

2 3-hour laboratory periods, credit, 5.

Associate Professor JUDKINS and Mr. VAN HORN.

Prerequisite, Dairying 50.

75. **II. MARKET MILK.** — For seniors; juniors may elect. A study of market-milk conditions; extent and development of the business; supply and delivery; food value of milk and its uses as food; milk and its relation to the public health; proper methods for handling milk and cream for direct consumption; certified milk, requirements and production; pasteurizing; sterilizing; standardizing and modifying; milk laws and inspection.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Professor LOCKWOOD and the DEPARTMENT.

Prerequisite, Dairying 50.

76. **III. MILK PRODUCTS.** — For seniors; juniors may elect. The manufacture of milk products other than butter, including cheddar cheese, soft and fancy cheese, ice cream, condensed milk, casein, milk powder, etc. Laboratories, largely the making of soft and fancy cheese and ice cream.

2 class hours.

2 3-hour laboratory periods, credit, 5.

Mr. WHEELER.

Prerequisite, Dairying 75.

77. **I. DAIRYING.** — For seniors; juniors may elect. A general course designed primarily for students who wish to take only one course in dairying. The work given will cover briefly the composition and secretion of milk, the Babcock fat test, the relation of bacteria to dairy work and principles of creaming; separators; elementary butter making; proper methods of handling milk and cream; and the relation of market milk to the public health.

3 lecture hours.

2 2-hour laboratory periods, credit, 5.

Mr. WHEELER and the DEPARTMENT.

Farm Management.

Professor FOORD, Assistant Professor ABELL, Mr. SPENCER.

The purpose of the courses in this department is to introduce the student to a consideration of farming as a business. This involves a knowledge of the cost of production and the profit from the different enterprises such as dairy, poultry or orchard, and a study of the enterprises, and the relative amounts of each that will give the best use of labor and equipment on the farm under consideration.

The college farm of 250 acres is under the general supervision of the Department of Farm Management, and furnishes demonstration material. It includes improved land, pasture land and a farm wood lot. The improved land illustrates the value of good culture and the best known methods for the maintenance of fertility. The farm is equipped with suitable buildings and good machinery for the work carried on, of which the production of certified milk is an important branch. Several good farms in the vicinity, illustrating types of both special and general agriculture, may be inspected and studied. The offices of the department are in Stockbridge Hall.

Elective Courses.

75. **I. FARM COST ACCOUNTING.** — For seniors; juniors may elect. A study of farm inventories, single-enterprise accounts, complete farm accounts, and farm records. Special emphasis is given to the interpretation of results and their application in the organization and management of the farm.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Mr. SPENCER.

76. **III. FARM MANAGEMENT.** — For seniors; juniors may elect. The student should have had considerable farm experience before taking this course. Discussion and study of farming as a business; size, diversity and production and their influence on the farmer's labor income; relation of live stock to profits; regions and types of farming; cropping systems; arrangement of fields and buildings; use of labor, horses and machinery; marketing; methods of renting land; proper division of capital; choosing and buying a farm.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Professor FOORD.

Prerequisites, Agronomy 50, Animal Husbandry 25 and 26.

Poultry Husbandry.

Professor GRAHAM,¹ Associate Professor PAYNE, Dr. GOODALE, Mr. BANTA, Mr. DEAN.

The introductory courses (1, 50, 51, 52, 53, 54) give a knowledge of the general routine of elementary poultry keeping. The advanced studies prepare men for the successful operation of poultry plants, either as owners or managers. In the graduate work further preparation may be secured for teaching, extension or investigation.

The poultry plant consists of 8 acres of land sloping gently to the west. The buildings consist of three incubator cellars equipped with a number of lamp incubators and two mammoth machines with a total capacity of 9,000 eggs; a pipe brooder house (open pipe system) and 40 colony brooder houses which give a brooding capacity for 7,000 chicks, the equipment for these houses including a large variety of coal-stove brooders and kerosene hovers; a long laying house 14 by 180 feet, which accommodates 500 layers, furnishing facilities for student work in pen management, utility and fancy judging, etc.; and a laboratory 14 by 80, for killing, picking, drawing, trussing, packing, crate fattening and cramming. The fattening equipment consists of a modern sanitary all-steel battery with 16 compartments and 10 wooden crates, accommodating, altogether, 350 birds. There are also a storage building, 28 by 64 feet, for root cellar, poultry carpentry, poultry mechanics, feed room and storage; an experimental breeding house, 18 by 60; a combination laying, testing and breeding house, 18 by 72, for experimental purposes; a model laying house, 18 by 30, for 100 hens, and a house 20 by 40, for 200 hens. The six old experiment-station houses, each 12 by 18 feet, are used as special mating and overflow pens. The total capacity for laying hens is 1,600. A manure shed 14 by 18 feet; an oil and tool house 10 by 12; an incinerator 10 by 10; and two backyard model poultry houses 8 by 10 and 8 by 8 give a total of 76 buildings, not including a pheasant run, 16 roosting sheds 10 by 10, and numerous small coops for natural incubation and brooding.

Required Course.

1. **I. POULTRY HUSBANDRY.**—Given as part of the freshman agriculture and horticulture. The object of this course is to familiarize the student in a general way with the fundamental principles of poultry husbandry, — breeds and varieties of poultry, types of houses, feeds and feeding, management, marketing and the principles of incubation and brooding.

1 2-hour period, credit 1.

Mr. BANTA.

Elective Courses.

50. **I. ELEMENTS OF POULTRY CULTURE.**—For juniors; seniors may elect. This course consists of a comprehensive study of opportunities in poultry culture, poultry-house construction, poultry-house equipment, feeds and feeding, winter-egg production, types and breeds of poultry.

3 class hours.

Credit, 3.

Professor GRAHAM, Associate Professor PAYNE and Mr. BANTA.

¹ On leave of absence, 1919.

51. I. POULTRY PRACTICE WORK. — For juniors; seniors may elect. This is a practical laboratory course providing a study of external parasites, insecticides, poultry carpentry, caponizing, killing and picking; dressing and packing poultry.

2 2-hour laboratory periods, credit, 2.

Associate Professor PAYNE.

Prerequisite, must be accompanied by Poultry 50.

52. II. ELEMENTS OF POULTRY CULTURE. — For juniors; seniors may elect. This course treats the subjects of incubation, brooding, care of growing stock, breeding for egg-production and diseases of poultry.

3 class hours.

Credit, 3.

Associate Professor PAYNE and Mr. BANTA.

Prerequisite, Poultry 50.

53. III. INCUBATION AND BROODING. — For juniors; seniors may elect. In this course students are required to set up and operate incubators and brooders, make a systematic study of the development of the chick in the egg and the care of sitting hens. Laboratory time by arrangement.

1 class hour.

4 2-hour laboratory periods, credit, 5.

Associate Professor PAYNE.

Prerequisite, Poultry 52.

54. III. PEN MANAGEMENT. — For juniors; seniors may elect. This is a practical laboratory course. Students are required to care for a pen of fowls, keeping accurate records of eggs produced, food consumed, weather conditions, health of fowls and profit and loss.

1 2-hour laboratory period, credit, 1.

Mr. BANTA.

Prerequisite, Poultry 50.

55. I., II. and III. INVESTIGATIONAL WORK. — Seniors. This course is designed especially for students who are planning to do experiment station work. Students will be assigned specific problems to work out experimentally, or they may be required to assist in carrying on such work.

1 to 5 2-hour laboratory periods, credits, 1 to 5.

Dr. GOODALE.

75. II. POULTRY MANAGEMENT. — Seniors. A detailed study of large poultry farms and their equipment, such as bone cutters, feed cutters, craming machines, etc.; the laying out and planning of poultry buildings of all kinds; mating of fowls. Attention to poultry diseases and investigation work carried on by experiment station is prominent. A few good poultry plants will be visited by the class for practical demonstrations.

5 class hours.

Credit, 5.

Professor GRAHAM.

Prerequisites, Poultry 53, 54, 76 and 77.

76. I. ADVANCED POULTRY JUDGING. — Seniors. This course includes a study of the origin and history of breeds and varieties, poultry organizations and poultry shows. The laboratory work covers score card and compara-

tive judging of exhibition and utility poultry; conditioning show birds, and applying the latest methods of selecting high and low producing hens. A few of the best Connecticut Valley poultry shows will be visited by the class. The American Standard of Perfection will be used as a text.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Mr. BANTA.

Prerequisite, Poultry 53.

77. I. MARKET POULTRY AND POULTRY PRODUCTS. — Seniors. This course includes the study of market classifications of poultry, eggs and feathers, the requirements of different markets, methods of marketing, advantages and disadvantages of cold storage of poultry and eggs. Students will be required to fatten several lots of chickens by different methods and rations. Accurate data must be kept showing the gain in weight and quality, also the cost of feed, labor, etc., and the profit and loss. Preserving eggs, judging and scoring of market poultry, both alive and dressed, and market eggs will be an important feature of this course.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Associate Professor PAYNE.

Prerequisites, Poultry 50, 51 and 52.

Rural Engineering.

Professor GUNNESS, Assistant Professor STRAHAN, Mr. PUSHEE, Mr. NEWLON.

The courses in rural engineering are planned to give a working knowledge of those phases of engineering which apply directly to the farm. It is expected that the student will get a clear understanding of modern farm practice as it relates to permanent improvements of the farm and the farmstead, and in the selection and use of farm equipment.

This department has an office and the use of a lecture room in Stockbridge Hall. The work on farm structures is given in the large drawing room in the same building. This room is fitted with thirty drawing tables. Models and blue prints are available for the study of farm buildings. A set of post molds and a machine for making cement tile afford opportunity for practical work with cement.

The rural engineering shop building is a one-story structure 68 by 126 feet. The carpenter shop in this building is fitted with benches fully equipped with tools for each student. A saw table is available for getting out material. The general repair shop is equipped with forges, benches, a drill press and grinders. The laboratory for farm machinery and farm motors is equipped with a complete line of field machines, gasoline engines, tractors and pumps. A complete assortment of engine accessories, consisting of carburetors, magnetos, etc., is available for thorough instruction in gas engines. A small dynamo and switchboard are used in the study of farm-lighting systems. The work on the small field machines is given in the basement of Stockbridge Hall, and the work on steam engines and steam heating is given in Flint Laboratory.

Elective Courses.

25. **I. and III. CARPENTRY.** — For sophomores; juniors and seniors may elect. Practice in the use of tools by exercises in bench work, repair of farm equipment and farm building construction.

2 2-hour laboratory periods, credit, 2.

Mr. PUSHEE.

26. **II. and III. REPAIR OF FARM EQUIPMENT.** — For sophomores; juniors and seniors may elect. Exercises in forge work, pipe fitting, soldering, babbitting and fitting bearings, lining up shafting, lacing belts and splicing rope. Practice in the use of machinist's tools, such as file, cold chisel, drill press, taps and dies.

2 2-hour laboratory periods, credit, 2.

Mr. NEWLON.

75. **I.** For seniors; juniors may elect. Study of the strength and durability of building materials; water supply; lighting and heating systems for the farm; lightning protection; drawing plans, writing specifications and estimating the cost of buildings; concrete construction as applied to foundations, silos, tanks, posts, floors and walks.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Assistant Professor STRAHAN.

77. **II. POWER MACHINERY.** — For seniors; juniors may elect. Steam and gasoline engines, refrigerating machinery, electric motors and dynamos. Practice in pipe fitting, soldering, babbitting and fitting bearings, lacing belts and packing valves. Course 77 is intended primarily for dairy students, but would be valuable to any man who would expect to use engines, pumps or electrical machinery.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Professor GUNNESS.

78. **III. FARM MACHINERY.** — For seniors; juniors may elect. Study of the care and operation of tillage, seeding, harvesting, pumping and spraying machinery; steam and gas engines and gas tractors. Special attention will be given to the use of power on the small farm.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Professor GUNNESS.

79. **III. DRAINAGE AND IRRIGATION ENGINEERING.** — For seniors; juniors may elect. This course covers the engineering phase of drainage and irrigation. The various systems are studied, and practice is given in the design of drainage and irrigation systems. Field work gives practice in surveying for drains, platting, locating drains, erecting batterboards and laying tile. Practice is given in assembling equipment for spray irrigation, and the flow of water through nozzles is studied by means of laboratory tests.

1 class hour.

1 4-hour laboratory period, credit, 3.

Assistant Professor STRAHAN.

Prerequisite, must be taken with Agronomy 76.

DIVISION OF HORTICULTURE.

Professor WAUGH.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Floriculture.

Associate Professor THAYER.

The courses in floriculture are intended to give the student a general knowledge of all phases of greenhouse design, construction, heating and management, the culture of florists' crops (under glass and in the field), floral decoration and arrangement. The department aims to train students so that they may take up commercial floriculture (either in the growing or retail business) and the management of conservatories on private estates, in parks and cemeteries.

The department is especially well equipped for the teaching work, probably being surpassed in no other agricultural college. French Hall, with its laboratories, classrooms and offices, furnishes excellent facilities for the purposes of instruction. The glass area of the department consists of approximately 20,000 square feet, divided as follows: French Hall range of 7,200 square feet, a durable, practical, commercial range composed of palm and fern, violet, carnation, rose and students' houses; the old Durfee range of 7,400 square feet, devoted to the growing of decorative, conservatory and bedding plants and chrysanthemums; one house of 3,200 square feet, suitable for propagating work and general plant culture; and approximately 2,200 square feet in cold frames and hotbeds.

In addition, the department has 2 acres of land used for the summer culture of carnations, violets, gladioli, dahlias, sweet peas, bedding plants, etc. This also includes a small garden of about 4,700 square feet devoted to the culture of annuals. A large collection of biennials and herbaceous perennials is maintained and is being enlarged from year to year; at the present time the collection consists of 700 species and varieties, and provides an excellent opportunity for the study of garden flowers.

Elective Courses.

50. I. GREENHOUSE MANAGEMENT. — For juniors; seniors may elect. This course is designed to familiarize students with the methods followed in the management of greenhouse crops. The students are instructed in the practical operations of watering, potting, fumigating, ventilating and in the methods of propagation of plants. In addition the use of cut flowers and plants in decorative work, arrangement of flowers in baskets, designs, vases, table and home decorations will be considered. Students will be expected to arrange their hours according to the needs of the work.

2 class hours.

1 4-hour laboratory period, credit, 4.

Associate Professor THAYER.

Prerequisite, Horticulture 27.

51. **II. GREENHOUSE MANAGEMENT.** — For juniors; seniors may elect.
Continuation of Course 50.

2 class hours.

1 4-hour laboratory period, credit, 4.

Associate Professor THAYER.

Prerequisite, Floriculture 50.

52. **III. GREENHOUSE MANAGEMENT.** — For juniors; seniors may elect.
A continuation of Courses 50 and 51.

2 class hours.

1 4-hour laboratory period, credit, 4.

Associate Professor THAYER.

Prerequisite, Floriculture 51.

53. **I. GREENHOUSE CONSTRUCTION.** — For juniors; seniors may elect.
The location, arrangement, construction, cost, heating and ventilating of greenhouse structures; also the drawing of plans and drafting of specifications for commercial houses and private ranges. Such practical work as glazing, the construction of concrete benches and cold frames will be included in this course.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor THAYER.

Prerequisite, should be taken with Floriculture 50.

54. **II. GREENHOUSE CONSTRUCTION.** — For juniors; seniors may elect.
A continuation of Course 53.

2 class hours.

1 2-hour laboratory period.

Associate Professor THAYER.

Prerequisite, Floriculture 53.

75. **I. COMMERCIAL FLORICULTURE.** — Seniors. A detailed study will be made of the methods of culture for greenhouse plants and cut flowers for wholesale and retail markets. The care and marketing of all florists' crops will also be considered. Assigned readings on these topics.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor THAYER.

Prerequisite, Floriculture 52.

76. **III. COMMERCIAL FLORICULTURE.** — Seniors. As stated under Course 75.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor THAYER.

Prerequisites, Floriculture 75 and 80.

77. **II. CONSERVATORY WORK AND DECORATIVE PLANTS.** — Seniors. A study of the tropical and subtropical foliage and flowering plants used in conservatory work. Their arrangement and care will also be considered. Assigned readings.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor THAYER.

Prerequisite, Floriculture 75.

78. **III. GARDEN FLOWERS AND BEDDING PLANTS.** — Juniors and seniors. This course aims to make the student familiar with those annuals, herbaceous perennials, bulbs and bedding plants used in landscape work. Their propagation, culture and uses will be considered. Assigned readings and field trips. 2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor THAYER.

79. **III. SEMINAR.** — For seniors majoring in floriculture only. Advanced study of subjects pertaining to commercial floriculture or private garden work. All students electing this work will be assigned a specific problem, and will pursue study in these problems by reading and research. No regular lectures will be given, but seminars will be conducted each week. A satisfactory report of the results must be presented.

2 to 6 laboratory hours.

Not to exceed 3 credits.

Associate Professor THAYER.

80. **II. COMMERCIAL FLORICULTURE.** — Seniors. As stated under Course 75.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor THAYER.

Prerequisite, Floriculture 75.

Forestry.

Professor CLARK.

The forestry major is designed to give the student a grounding in the branches of natural science upon which forest development is based. It continues, further, to give him a knowledge of such practical forestry details as the distinguishing characteristics of the various species of trees and commercial lumber, the principles of silviculture, forest management, forest utilization, and forest nursery practice.

The department has an unusually complete equipment of the various instruments used in forest mensuration, forest mapping and engineering, timber estimating, log scaling, board measuring, etc.; and a large assortment of boards illustrative of the various commercial woods found in the lumber markets. The State Forest Nursery, comprising 6 acres of land and containing, approximately, 5,000,000 trees, transplants and seedlings, is on the college farm. Extensive forests containing every variety of tree common to New England are within walking distance of the college. The college campus affords an arboretum containing an exceptionally large number of trees not native to New England. The Mount Toby Demonstration Forest has an area of approximately 750 acres, and contains the various types of forest growth found throughout the State. It serves as a field laboratory in which students have the privilege of working out problems in silviculture, forest mensuration and management. Improvement cuttings, cuttings for utilization, and forest plantings are conducted by the forestry department, and every opportunity is offered the student to familiarize himself with the practical side of forest work.

Elective Courses.

50. **I. DENDROLOGY.** — For juniors; seniors may elect. During the first part of the term frequent field trips will be made to identify and study the habits of our native forest trees. Later, the classification, range, distribution, forest habits, quality, uses and identification of wood of the commercial timber trees of the United States will be studied. Lectures, recitations, laboratories or field work at option of instructor.

3 2-hour laboratory periods, credit, 3.

Professor CLARK.

51. **II. WOOD TECHNOLOGY.** — For juniors; seniors may elect. A study of the commercial woods found in the lumber markets, methods of identification, uses, strength values, technical qualities, decay and methods of preservation.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Professor CLARK.

52. **III. PRINCIPLES OF FORESTRY.** — For juniors; seniors may elect. A lecture course for the purpose of giving the students a general view of the whole field of forestry and what forestry attempts to accomplish and has accomplished. Not required of students who propose to major in forestry.

2 class hours.

Credit, 2.

Professor CLARK.

53. **III. SILVICULTURE.** — For juniors; seniors may elect. Factors influencing forest growth; forest types; silvicultural systems; care and protection of forests; forest description; forest nursery practice and forest planting.

1 class hour.

1 4-hour laboratory period, credit, 3.

Professor CLARK.

Prerequisite, Forestry 50.

54. **IV. ARBORICULTURE.** — For juniors; seniors may elect. A course dealing with problems of shade tree propagation, protection and repair; the choice and grouping of species; shade tree laws. Assigned readings.

120 hours' field work, credit, 5.

Professor CLARK.

75. **I. FOREST MENSURATION.** — For seniors; juniors may elect. Methods of determining the volume of trees, logs and entire forests. Methods of computing volume tables, tree and forest growth and yield tables. Timber estimating.

3 class hours.

72 hours' field work, credit, 5.

Professor CLARK.

78. **III. SEMINAR — REPORT.** — Seniors. This may involve research, laboratory or field work in the investigation of some subject, together with a review of the literature relating to it and an original written report evidencing the results. Subject to be chosen in conference with Professor Clark.

6 laboratory hours, credit, 3.

Professor CLARK.

Horticultural Manufactures.

Professor CHENOWETH.

The courses offered aim to give the student a practical knowledge of the problems connected with food preservation. Emphasis is placed upon the conservation of the cheaper grades of fruits and vegetables, to the end that the whole crop may be marketed at a profit and that good wholesome food products may result from what would otherwise be lost.

The social and economic values of this line of work are constantly emphasized with the intent of broadening and liberalizing the students' view of these problems.

The department occupies three laboratory rooms in Flint Laboratory, two in Fisher Laboratory, with offices in Wilder Hall and French Hall. The laboratories are fitted with desks for 18 students. The desk equipment contains the necessary utensils for doing general laboratory work in food preservation. The general equipment of the department, both for the use of students and for manufacturing purposes, may be grouped under the following heads: —

1. *Canning.* — A modern canning outfit, including both steam-pressure cookers and hot-water baths, hand and power can sealers, peeling and slicing machines, a string-bean cutter, heat-penetration thermometers, electric incubator and a large assortment of all types of home canning equipment.

2. *Evaporation.* — Two small orchard evaporators, a tunnel drier, peeling machines, slicers and a general assortment of driers adapted to home evaporation.

3. *Fruit Juices, Butters, etc.* — A hand cider mill, a motor-driven hydraulic press, a steam-jacketed kettle, an apple-butter cooker, and cider and vinegar testing apparatus.

Elective Courses.

75. **I. HORTICULTURAL MANUFACTURES.** — For seniors and graduate students. A practical course in food preservation dealing primarily with fruits and vegetables. The canning of fruits and vegetables as practiced in the home and in commercial canneries; evaporation of fruits and vegetables, the various types of equipment and methods of preparation of products. The manufacture of (a) fruit products, such as butters, jams, jellies, fruit juices, marmalades, preserves, vinegars, pastes, etc.; (b) vegetable products, as pickles, piccalilli, sauerkraut, soups, etc. Particular attention will be given to study and use of all types of equipment suitable for use in the home or small factory, together with methods for testing a large variety of manufactured products. During this term the emphasis will be on canning, drying and study of equipment.

2 class hours.

3 2-hour laboratory periods per week, credit, 5.

Professor CHENOWETH.

76. **II. HORTICULTURAL MANUFACTURES.** — For seniors and graduate students. A continuation of Course 75. The emphasis in this course is placed on the manufacturing and testing of fruit and vegetable products.

1 class hour.

2 laboratory periods per week, credit, 3.

Professor CHENOWETH.

Prerequisite, Horticultural Manufactures 75.

Horticulture.

Professor WAUGH, Assistant Professor THOMPSON.

The general subject of horticulture divides naturally into subjects of pomology, floriculture, forestry, landscape gardening and market gardening. A number of courses relate to more than one of these subjects, and are therefore grouped here under the general designation of horticulture.

Required Course.

1. I. 2. II. 3. III. HORTICULTURE. — Freshmen. Given as part of the freshman agriculture and horticulture.

Elective Courses (General).

27. III. NURSERY PRACTICE. — For sophomores; juniors and seniors may elect. This course treats of the fundamental methods of plant propagations by seeds, cuttings, budding, grafting, etc. Lectures and practicums.

2 class hours.

1 2-hour laboratory period, credit, 3.

Assistant Professor THOMPSON.

50. I. PLANT MATERIALS. — For juniors; seniors may elect. This course aims to make the student familiar with the character of the trees, shrubs and herbaceous perennials used in ornamental work, and with the methods of propagating them.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Assistant Professor THOMPSON.

Prerequisite, Horticulture 27.

51. III. PLANT MATERIALS. — For juniors; seniors may elect. A continuation of Course 50, taking up the field use of trees, shrubs and herbaceous plants, their native habitats, soils and plant associations, with a view to supplying to students in landscape gardening and floriculture a knowledge of plant species. Frequent practicums and field excursions.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Assistant Professor THOMPSON.

Prerequisite, Horticulture 50.

Landscape Gardening.

Professor WAUGH, Assistant Professor HARRISON.

The purposes of the courses in landscape gardening are: (1) to train men for the profession in all its branches. As a rule graduates should first enter the employ of established landscape architects, nurserymen or park superintendents, and after an apprenticeship of several years those who have the requisite technical and business ability may set up for themselves. (2) To train men for public-service work in national, State and municipal parks and forests. (3) To train men for country planning, this function being exercised through various public institutions and organizations. (4) To train teachers and extension workers in lines of landscape gardening and civic improvement. (5) To give a broad and liberal general education stressing the fundamental principles of art.

The department has large, well-lighted drafting rooms, with all necessary equipment, such as planimeters, eidograph, pantograph, blue-printing outfit, etc.; and a complete outfit of surveying instruments, including transits, levels, plane tables, prismatic compasses, hand levels, etc. The college campus presents an unusually good collection of the plant materials used in landscape gardening.

Elective Courses.

50. **I. MAPPING AND TOPOGRAPHY.** — Juniors. Reconnaissance surveys and mapping, with special reference to the methods used in landscape gardening; detailed study of selected designs of leading landscape gardeners; grade design, road design and field work. Must be followed by Course 51.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.

Assistant Professor HARRISON.

Prerequisites, Mathematics 26 and 27, Drawing 25, 26 and 27, Horticulture 27.

51. **II. ELEMENTS OF LANDSCAPE GARDENING.** — Juniors. As stated under Course 50.

3 3-hour laboratory periods, credit, 4.

Assistant Professor HARRISON.

Prerequisite, Landscape Gardening 50.

52. **III. GENERAL DESIGN.** — Juniors. Field notes; examination of completed works and those under construction; design of architectural details, planting plans, gardens, parks and private grounds; written reports on individual problems. Must be followed by Course 53.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.

Assistant Professor HARRISON.

Prerequisites, Landscape Gardening 50 and 51, and either plant materials (Horticulture 50 and 51) or advanced mathematics.

80. **I. GENERAL DESIGN.** — Juniors. As stated under Course 52. [Will be given in the summer term when that is established; meantime, will be given in term I, senior year.]

120 laboratory hours, credit, 5.

Professor WAUGH.

Prerequisite, Landscape Gardening 52.

75. **I. THEORY OF LANDSCAPE ART.** — For seniors and graduates. The general theory and applications of landscape study, including a brief history of the art.

3 class hours.

Credit, 3.

Professor WAUGH.

76. **II. CIVIC ART.** — Seniors. The principles and applications of modern civic art, including city planning, city improvement, village improvement and rural improvement, with special emphasis upon country planning. Must be followed by Course 77.

3 3-hour laboratory periods, credit, 4.

Professor WAUGH.

Prerequisite, Landscape Gardening 53.

77. **III. COUNTRY PLANNING.** — Seniors. As stated under Course 76.
3 3-hour laboratory periods, credit, 4.
Professor WAUGH.

Prerequisite, Landscape Gardening 76.

78. **III. ARCHITECTURE.** — Alternating with Course 79; given in 1918-19. Juniors and seniors. The history of architectural development, the different historic types, with special reference to the underlying principles of construction and design and their relations to landscape design. Illustrated lectures, conferences, practice in designing.
3 class hours.

Credit, 3.

Assistant Professor HARRISON.

79. **III. CONSTRUCTION AND MAINTENANCE.** — Alternating with Course 78; given in 1919-20. Juniors and seniors. Detailed instruction in methods of construction and planting in carrying out plans, in organization, reporting, accounting, estimating, etc.; maintenance work in parks and on estates, its organization, management, cost, etc.
3 class hours.

Credit, 3.

Assistant Professor HARRISON.

Pomology.

Professor SEARS, Assistant Professor DRAIN, Mr. GOULD.

The object of the courses in pomology is to give the student a training which shall be at once thoroughly practical and yet scientific. This will fit the men to enter the field of practical fruit-growing, or it will furnish an excellent foundation for further study in case the student elects to take up research or teaching work.

The department has 50 acres in fruit plantations. The apple orchards are the most extensive, comprising about 35 acres of various ages, but there are also blocks of pears, peaches, plums and cherries. In small fruits there are plantings of strawberries, raspberries, blackberries, currants and gooseberries. There are three vineyards, with a total area of 5 acres, in which the leading varieties and the principal types of pruning and training are represented. In these plantations are 50 varieties of grapes, representing three native American species and many hybrids; 20 varieties of peaches; 20 varieties of pears; 25 of plums, including five species and many hybrids; and 100 varieties of apples.

The department has an excellent equipment of spraying and dusting machinery, including various styles and sizes of power sprayers, and many types of barrel pumps and smaller sprayers. There is also an excellent assortment of orchard tools, including plows, harrows, fertilizer sowers, etc.

Fisher Laboratory is one of the best planned and equipped packing and storage plants to be found in the United States. It includes six refrigerated rooms of various sizes; four storage rooms not refrigerated; one large laboratory room and one classroom, besides ample storage room for fruit packages and equipment. The equipment for the building itself includes four types of apple sizers; packing tables and box and barrel presses of various types, besides all kinds of packages and the smaller equipment necessary for thor-

oughly modern work in grading and packing fruit. The department is well equipped with lockers and with pruning and other tools for the use of students in laboratory work. Such work is made a leading feature in all the courses in pomology.

Elective Courses.

50. **I. PRACTICAL POMOLOGY.** — For juniors; seniors may elect. A study of the general principles of the growing of fruits, dealing with such questions as selection of site, soils, windbreaks, laying out plantations, choice of nursery stock, pruning, culture of orchards, orchard fertilizers, cropping orchards, etc. Lectures, supplemented with text and reference books; field and laboratory exercises.

2 class hours.

1 2-hour laboratory period, credit, 3.

Professor SEARS.

Prerequisite, Horticulture 27.

51. **II. PRACTICAL POMOLOGY.** — For juniors; seniors may elect. As stated under Course 50.

2 class hours.

1 2-hour laboratory period, credit, 3.

Professor SEARS.

Prerequisite, Pomology 50.

52. **III. PRACTICAL POMOLOGY.** — For juniors; seniors may elect. As stated under Course 50.

2 class hours.

1 2-hour laboratory period, credit, 3.

Professor SEARS.

Prerequisite, Pomology 51.

53. **IV. (Summer.) SMALL FRUITS.** — For juniors; seniors may elect. The growing, harvesting, marketing and storing of small fruits, including currants, gooseberries and grapes, together with thinning, spraying, picking and marketing of tree fruits at the college orchards and in private commercial orchards.

120 laboratory hours, credit, 5.

The DEPARTMENT.

75. **I. SYSTEMATIC POMOLOGY.** — Seniors. A study of the varieties of the different fruits and of nomenclature, with critical descriptions; special reference being given to relationships and classification. Lectures, laboratory and field exercises.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Assistant Professor DRAIN.

Prerequisite, Pomology 52.

76. **II. SYSTEMATIC POMOLOGY.** — Seniors. As stated under Course 75.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Assistant Professor DRAIN.

Prerequisite, Pomology 75.

77. **I. COMMERCIAL POMOLOGY.** — Seniors only, majoring in pomology. The picking, handling, storing and marketing of fruits, including a discussion of storage houses, fruit packages, methods of grading and packing. Especial

emphasis is placed upon laboratory and field work, where the student is given actual practice in the picking and packing of all the principal fruits.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Assistant Professor DRAIN.

Prerequisite, Pomology 52.

78. **III. SPRAYING.** — Seniors. A study of (a) spraying materials, their composition, manufacture and preparation for use; the desirable and objectionable qualities of each material, formulas used, cost, tests of purity. (b) Spraying machinery, including all the principal types of pumps, nozzles, hose and vehicles; their structure and care. (c) Orchard methods in the application of the various materials used, with the important considerations for spraying each fruit and for combating each orchard pest. This course is designed especially to familiarize the student with the practical details of actual spraying work in the orchard. Spray materials are prepared, spraying apparatus is examined and tested, old pumps are overhauled and repaired, and the actual spraying is done in the college orchards and small-fruit plantations.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Professor SEARS.

Prerequisite, Pomology 52.

79. **III. GENERAL POMOLOGY.** — For seniors; juniors may elect. This course is planned to meet the needs of those students who cannot devote more than one term to the subject but who want a general knowledge of fruit growing. The work will consist of lectures and laboratory exercises on such topics as choosing the locations, kinds and varieties of fruits to grow, securing and setting the plants, care and cultivation, pruning, spraying, pests, harvesting and storing.

2 class hours.

1 2-hour laboratory period, credit, 3.

Assistant Professor DRAIN.

80. **I. SEMINAR.** — For seniors majoring in pomology. Advanced study of problems relating to the business of fruit growing. Each student will be assigned a major and a minor problem in lines of work in which he is particularly interested. He will pursue his studies both by reading and research, and the materials obtained will be worked into theses which will be presented to the seminar for discussion. Reports on minor problems will be taken up first. No lectures will be given, but seminar meetings will be held for one period each week.

Credit, 1.

Professor SEARS.

81. **II. SEMINAR.** — For seniors majoring in pomology. A continuation of Course 80. One seminar meeting each week.

Credit, 1.

Professor SEARS.

82. **III. SEMINAR.** — For seniors majoring in pomology. A continuation of Course 81. One seminar meeting each week.

Credit, 1.

Professor SEARS.

Vegetable Gardening.

Professor TOMPSON, Associate Professor DACY.

Course 50 is offered for students who desire a general view of the subject, which may be secured in one term. The other courses cover very thoroughly the principles and practices of the commercial production of vegetables in the open, and the forcing of vegetables in cold frames, hotbeds and greenhouses. They are designed for students who wish to engage in the business for themselves or for others, or who wish to become teachers or investigators in the more technical phases of the subject.

The department has 12 acres of land, greenhouses, hotbeds and cold frames, with modern equipment devoted to the production of a wide variety of crops. These afford excellent subject-matter for study, and opportunity for close contact with the actual problems of the business.

Elective Courses.

50. **I. GENERAL VEGETABLE GARDENING.** — Juniors; seniors may elect. A general course for students not specializing in vegetable gardening. Designed to teach the fundamentals of vegetable gardening. Soils, fertilizers, garden crops, general methods of management. [Offered for first time in 1919-20.]

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor DACY.

51. **I. PRACTICAL VEGETABLE GARDENING.** — Juniors; seniors may elect. A study of the principles of vegetable gardening. Deals with such questions as the selection of a location; soils, manures and fertilizers, green manure and cover crops; seeds and seeding; the construction and management of hotbeds and cold frames; garden planning, planting, tillage, irrigation; control of insects and diseases; harvesting, marketing and storing. Includes a detailed study of the cultural requirements of the common vegetable crops, and the principles of rotation and double cropping. Text and reference books. Laboratory and field exercises.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor DACY.

Prerequisite, Horticulture 27.

52. **II. PRACTICAL VEGETABLE GARDENING.** — Juniors; seniors may elect. As stated under Course 51.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor DACY.

Prerequisite, Vegetable Gardening 51.

53. **III. PRACTICAL VEGETABLE GARDENING.** — Juniors; seniors may elect. As stated under Course 51.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor DACY.

Prerequisite, Vegetable Gardening 52.

54. **IV. VEGETABLE GARDENING PRACTICE.** — Field work in summer term after junior year. The work of this course will be under the direct supervision of an instructor, and will give the student an unusual opportunity to learn, at first hand, the methods and problems of commercial vegetable growing. Most of the work will be in the field devoted to seed planting, cultural practices, harvesting and preparing for market. Required of those majoring in vegetable gardening.

120 laboratory hours, credit, 5.

Prerequisite, Vegetable Gardening 53.

75. **I. SYSTEMATIC VEGETABLE GARDENING.** — Seniors. This course will include the systematic study of varieties, types and strains of the leading vegetable crops; the establishing of types, determination of quality of varieties; seed growing, variety improvement, roguing, seed harvesting, curing and storing.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Associate Professor DACY.

Prerequisite, Vegetable Gardening 54.

76. **II. GREENHOUSE CONSTRUCTION AND VEGETABLE FORCING.** — Seniors. A study of types, materials, construction, location, arrangement, capacity and cost of greenhouses for growing vegetables. A brief consideration of the heating plant, — the type, installation, piping and management; also the study of greenhouse vegetable crops and their production as practiced by commercial growers.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Associate Professor DACY.

Prerequisite, Vegetable Gardening 75.

77. **III. COMMERCIAL VEGETABLE GROWING.** — Seniors. A consideration of vegetable growing as a business. A study of this specialized type of farming, including places where developed, types, extent, economic importance, capitalization, equipment and other fundamental problems of commercial vegetable gardening. Students will assist in the planning and operation of a typical market-gardening area. Visits will be made to market-gardening and truck-gardening farms.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Associate Professor DACY.

Prerequisite, Vegetable Gardening 76.

78. **I. SEMINAR.** — For seniors majoring in vegetable gardening. Each student will be assigned problems relating to the business of vegetable gardening. Reports on the work on these problems will be made each week to the seminar, and the results presented as a thesis.

Credit, 1.

Professor TOMPSON and Associate Professor DACY.

79. **II. SEMINAR.** — For seniors majoring in vegetable gardening. A continuation of Course 78. One seminar meeting each week.

Credit, 1.

Professor TOMPSON and Associate Professor DACY.

80. **III. SEMINAR.** — For seniors majoring in vegetable gardening. A continuation of Course 79. One seminar meeting each week.

Credit, 1.

Professor TOMPSON and Associate Professor DACY.

Drawing.

Elective Courses.

25.¹ **I. FREE-HAND DRAWING.** — For sophomores; juniors and seniors may elect. Lettering; free-hand perspective; sketching from type models, leaves, flowers and trees, houses, etc.; laying flat and graded washes in water colors; water-color rendering of leaves, flowers and trees; conventional coloring and map rendering in water colors; conventional signs and mapping in ink.

3 2-hour laboratory periods, credit, 3.

26.¹ **II. MECHANICAL DRAWING.** — For sophomores; juniors and seniors may elect. Inking exercises; geometric problems; projection; intersections; isometric; shades and shadows; parallel; angular and oblique perspective; perspective drawing of buildings. Students should have preparation in plane and solid geometry.

3 2-hour laboratory periods, credit, 3.

27.¹ **III. MECHANICAL DRAWING.** — For sophomores; juniors and seniors may elect. As stated under Course 26.

3 2-hour laboratory periods, credit, 3.

Prerequisite, Drawing 26.

¹ Given by Assistant Professor Harrison.

DIVISION OF SCIENCE.

Professor FERNALD.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Botany.

Professor OSMUN, Associate Professor ANDERSON, Assistant Professor CLARK, Assistant Professor McLAUGHLIN, Dr. TORREY.

A knowledge of the principles of plant life is fundamental in agricultural education. The required courses in botany are planned with this and the general educational value of the subject in view. Elective courses are of two types: (1) those which have for their chief aim the direct support of technical courses in agriculture and horticulture, and (2) those providing broader, more intensive training in the science. Courses in the second group may lead, when followed by postgraduate study, to specialization in the field. They also furnish excellent training for those specializing in other sciences and in scientific agriculture. In all undergraduate courses the relation of the science of botany to agriculture is emphasized.

The department occupies Clark Hall, a brick building 55 by 95 feet, two stories high, with basement and attic. The building has two lecture rooms with seating capacity of 154 and 72, respectively; one seminar and herbarium room; large laboratories for general and special work; and smaller rooms for advanced students. A glass-enclosed laboratory for plant physiology adjoins the main building and provides unusual facilities for the study of phenomena of plant life. In addition, a greenhouse 28 by 70 feet is connected with the building. This is for experimental work in plant pathology and physiology, and for growing plants needed for instruction. The experiment station laboratories devoted to botanical research are in this building.

The laboratories and lecture rooms are of modern construction, finely lighted, and equipped with compound and dissecting microscopes, microtomes, paraffin and drying ovens, physiological and other apparatus, and a large collection of charts. The herbarium contains about 20,000 sheets of seed plants and ferns, 1,200 sheets of liverworts and mosses, and 25,000 specimens of fungi. Facilities and equipment for the study of plant physiology and pathology are excelled in few other institutions.

Required Courses.

3. **III. INTRODUCTORY BOTANY.** — Freshmen. This course presents the seed plants as plastic organisms molded by their environment. It also introduces the student to methods of identifying and classifying plants.

An herbarium, illustrative of systematic, ecological and economic features, is started in the spring, but need not be presented until fall when credit is given in Course 25. This makes it possible for the interested student to familiarize himself with the flora of the full growing season.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Dr. TORREY and Assistant Professor McLAUGHLIN.

25. **I. INTRODUCTORY BOTANY.**—Sophomores. The anatomy and physiology of the seed plants (Phanerogamia), with a brief summary of the lower forms of plant life. The herbarium started in connection with Botany 3 is presented as part of this course.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Dr. TORREY.

Prerequisite, Botany 3.

Elective Courses.

26. **II. MORPHOLOGY AND TAXONOMY OF THE LOWER PLANTS (CRYPTOGAMIA).**—Sophomores. Systematic study of typical forms of bacteria, algæ, fungi, lichens, mosses, ferns. (Courses 3, 25 and 26 constitute a general elementary course in botany, and are prerequisites of all subsequent work taken in the Department of Botany.)

1 class hour.

2 2-hour laboratory periods, credit, 3.

Professor OSMUN and Dr. TORREY.

Prerequisite, Botany 25.

50. **I. DISEASES OF CROPS.**—For juniors; seniors may elect. The lectures are general and are taken by all who elect the course, but in order to permit students to specialize on the diseases of crops most closely related to their majors or in which they are most interested, the course is divided for laboratory work into the following sections: (I) diseases of truck and field crops; (II) diseases of floricultural crops and ornamentals; (III) diseases of fruit crops; (IV) diseases of shade and forest trees. One, two or three laboratory sections may be taken.

1 class hour.

1, 2 or 3 2-hour laboratory periods, credits, 2, 3 or 4.

Assistant Professor McLAUGHLIN.

Prerequisite, Botany 26.

51. **II. DISEASES OF CROPS.**—For juniors; seniors may elect. As stated under Course 50.

1 class hour.

1, 2 or 3 2-hour laboratory periods, credits, 2, 3 or 4.

Assistant Professor McLAUGHLIN.

Prerequisite, Botany 50.

52. **I. SYSTEMATIC MYCOLOGY.**—For juniors; seniors may elect. Morphology and development of typical species representing the orders and families of fungi; practice in identification, collection and preservation of fungi; study of systems of classification; collateral reading. A prerequisite of the senior course in plant pathology, but open to all.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Associate Professor ANDERSON.

Prerequisite, Botany 26.

53. **II. SYSTEMATIC MYCOLOGY.**—For juniors; seniors may elect. As stated under Course 52.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Associate Professor ANDERSON.

Prerequisite, Botany 52.

54. **III. SYSTEMATIC MYCOLOGY.** — For juniors; seniors may elect. As stated under Course 52.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Associate Professor ANDERSON.

Prerequisite, Botany 53.

55. **I. PLANT HISTOLOGY.** — For juniors; seniors may elect. Comparative study of the tissues of plants; training in histological methods, including the use of precision microtomes, methods of killing, fixing, sectioning, staining and mounting; collateral reading and conferences. This course offers valuable training in preparation for further work in botany.

3 2-hour laboratory periods, credit, 3.

Professor OSMUN and Assistant Professor McLAUGHLIN.

Prerequisite, Botany 26.

56. **II. PLANT HISTOLOGY.** — For juniors; seniors may elect. As stated under Course 55.

3 2-hour laboratory periods, credit, 3.

Professor OSMUN and Assistant Professor McLAUGHLIN.

Prerequisite, Botany 55.

75. **I. PLANT PATHOLOGY.** — Seniors. Comprehensive study of diseases of plants; training in laboratory methods and technique, including culture work and artificial inoculation of hosts; miscellaneous diagnosis; study of literature and representative life histories of pathogens. Prepares for civil service, experiment station and college work.

1 class hour.

4 2-hour laboratory periods, credit, 5.

Professor OSMUN and Associate Professor ANDERSON.

Prerequisite, Botany 54.

76. **II. PLANT PATHOLOGY.** — Seniors. As stated under Course 75.

1 class hour.

4 2-hour laboratory periods, credit, 5.

Professor OSMUN and Associate Professor ANDERSON.

Prerequisite, Botany 75.

77. **III. PLANT PATHOLOGY.** — Seniors. As stated under Course 75.

1 class hour.

4 2-hour laboratory periods, credit, 5.

Professor OSMUN and Associate Professor ANDERSON.

Prerequisite, Botany 76.

78. **I. PLANT PHYSIOLOGY.** — Seniors. Study of the factors and conditions of (a) Plant Nutrition, including the taking up of water and mineral substances, the assimilation of carbon and nitrogen, and the release of energy due to the processes of dissimilation; (b) Plant Growth, including the influence of internal and external factors on growth, the development of reproductive and vegetative organs, and touching on plant inheritance and the origin of new varieties; (c) Plant Movements, including those due to the taking up of water, and those movements of both motile and fixed forms in response to external stimuli. Special emphasis is laid on the development of

skill in the manipulation of apparatus in the laboratory; weekly conferences are held at which students report on assignments to a large range of original papers.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Assistant Professor CLARK.

Prerequisites, Botany 26 and Chemistry 51.

79. **II. PLANT PHYSIOLOGY.** — Seniors. As stated under Course 78.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Assistant Professor CLARK.

Prerequisite, Botany 78.

80. **III. PLANT PHYSIOLOGY.** — Seniors. As stated under Course 78.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Assistant Professor CLARK.

Prerequisite, Botany 79.

82. **II. CYTOLOGY AND EMBRYOLOGY.** — Seniors. Morphology and physiology of the cell; cell-division; embryonal development.

3 2-hour laboratory periods, credit, 3.

Assistant Professor McLAUGHLIN.

Prerequisites, Botany 26 and 55.

83. **III. CYTOLOGY AND EMBRYOLOGY.** — Seniors. As stated under Course 82.

3 2-hour laboratory periods, credit, 3.

Assistant Professor McLAUGHLIN.

Prerequisite, Botany 82.

86. **I. SEMINAR.** — For seniors and graduate students. Presentation and discussion of important current botanical papers. A major requirement.

1 class hour.

Credit, 1.

The DEPARTMENT.

General and Agricultural Chemistry.

Professor LINDSEY, Professor WELLINGTON, Professor CHAMBERLAIN, Professor PETERS,
Professor —, Mr. SEREX, Mr. STURGIS, Mr. JEWELL, Mr. FANEUF.

In teaching the courses in chemistry, emphasis is laid on both their educational and their vocational value. The courses in the freshman year are intended to deal with fundamental principles, and to give the student such an understanding of the subject as will enable him to apply it in farm practice. The more advanced courses, including quantitative analysis and organic, physiological and physical chemistry, are intended primarily for those who intend to become teachers and workers in the allied sciences, or who desire to follow agricultural chemistry as a vocation. Advanced training is given by means of postgraduate courses (see Graduate School).

Those completing the undergraduate courses are fitted for positions in the agricultural industries, — fertilizer, feed and insecticide manufacture, — as well as in other lines of industry, and in the State experiment stations and in commercial laboratories. Postgraduate students are prepared for positions as teachers in high schools and colleges, and for more advanced positions in

industry and in the experiment stations. All men who were worthy of recommendation have secured positions.

An entire building is devoted to the needs of the department. The basement is used for the storage of apparatus and chemicals. The first floor contains laboratories for organic, physiological and physical chemistry, and qualitative analysis. The second floor is occupied by the general lecture room, the reading room, offices for the several members of the staff, and laboratories for analytical chemistry. The third floor has desk room and hoods sufficient to accommodate 90 students at one time in general chemistry. On this floor is also a lecture room seating 56 students.

The entire laboratory is well equipped with the necessary apparatus and chemicals for all students who desire to perfect themselves as expert chemists, or who wish to study chemistry as a supplement to some other kind of practical or scientific work. The equipment includes a valuable and growing collection of specimens and samples of minerals, soils, raw and manufactured fertilizers, foods, milk products, fibers, various other vegetable and animal products, and artificial preparations of mineral and organic compounds; and also a series of preparations for illustrating the various stages of different manufactures from raw material to finished product.

Required Courses.

1. **I. GENERAL CHEMISTRY.** — Freshmen. An introduction to the fundamental chemical laws, together with a study of the common acid-forming elements and their compounds. Textbook, Kahlenberg's "Outlines of Chemistry." This course is for those students who do not present chemistry for entrance, and who begin the subject in college.

2 class hours.

1 2-hour laboratory period, credit, 3.

Professor PETERS, Mr. SEREX and Assistants.

2. **II. GENERAL CHEMISTRY.** — Freshmen. A continuation of Course 1. A study of metals and their compounds. The laboratory work is the same as described under Course 4.

2 class hours.

1 2-hour laboratory period, credit, 3.

Professor PETERS and Assistants.

3. **III. INORGANIC AGRICULTURAL CHEMISTRY.** — Freshmen. As stated under Course 5, **II.**

2 class hours.

1 2-hour laboratory period, credit, 3.

Mr. SEREX and Assistants.

4. **I. ADVANCED GENERAL CHEMISTRY.** — Freshmen. A review of the fundamental chemical laws, together with the common acid and base-forming elements and their compounds. Textbook, Kahlenberg's "Outlines of Chemistry." The laboratory work takes the synthetic form. Substances of agricultural importance are prepared in quantity and studied in detail by the student. These include ammonium sulfate, superphosphate, muriate and sulfate of potash, arsenate of lead, Paris green, Bordeaux mixture, lime-sulfur and emulsions.

2 class hours.

1 2-hour laboratory period, credit, 3.

Mr. SEREX and Assistants.

Prerequisite, Entrance Chemistry.

5. **II. INORGANIC AGRICULTURAL CHEMISTRY.** — Freshmen. A study of the chemical composition, properties and reactions of soils, fertilizers, fungicides and insecticides. The laboratory work is divided into three parts, as follows: (a) qualitative examination of soil, plant ash and superphosphate; (b) approximate quantitative determination of moisture, ash, carbonic acid, phosphoric acid, potash, etc.; (c) special work on retention of salts by soil, leaching of lime from the soil by carbonated water, etc.
2 class hours. 1 2-hour laboratory period, credit, 3.
Mr. SEREX and Assistants.

6. **III. ORGANIC AGRICULTURAL CHEMISTRY.** — Freshmen. The course embraces the study of the most important groups of organic compounds of plants and animals, the composition of plants, the chemistry of plant growth, plants as food and as industrial material, the composition of animals, the chemistry of digestion, also the study of some of the products related to plants and animals, such as milk, butter, cheese, sugar and alcohol. The treatment of the subject will be general, avoiding (so far as possible) complicated chemical facts and relationships, and endeavoring simply to make the student acquainted with the general chemistry of plants and animals and agricultural processes and products.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor CHAMBERLAIN and Assistants.

Elective Courses.

25. **I. QUALITATIVE ANALYSIS.** — *Basic.* — Sophomores. A course in the systematic analysis of metallic salts, presented from the ionic viewpoint. The student studies closely the tests used in the separation and identification of the metals; he then applies these tests to unknown mixtures. Text, Medicus' "Qualitative Analysis," with Stieglitz' "Qualitative Analysis" and Gooch & Browning's "Qualitative Analysis" for reference. This course should be taken, particularly, by all intending to follow chemistry as a vocation.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Mr. SEREX and Mr. STURGIS.

Prerequisite, Chemistry 3 or 6.

26. **II. QUALITATIVE ANALYSIS.** — *Acidic.* — Sophomores. A continuation of Course 25.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Mr. SEREX and Mr. STURGIS.

27. **III. QUANTITATIVE ANALYSIS.** — For sophomores; juniors and seniors may elect. Instruction in this course includes the gravimetric and volumetric determinations of some of the commoner metals and non-metals. Talbot's "Quantitative Chemical Analysis" is used as a text.
1 class hour. 2 4-hour laboratory periods, credit, 5.

Professor WELLINGTON and Professor PETERS.

Prerequisite, Chemistry 25. Course 26 is prerequisite for those majoring in chemistry.

30. **III. ORGANIC AGRICULTURAL CHEMISTRY.** — For sophomores; juniors and seniors may elect. As described in Course 6. To be elected by those who have not had Chemistry 6.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Professor CHAMBERLAIN and Mr. FANEUF.

51. **I. ORGANIC CHEMISTRY.** — For juniors; seniors may elect. This course consists of a systematic study, both from texts and in the laboratory, of the more important compounds in the entire field of organic chemistry. Especial attention is given to those compounds which are found in agricultural products or are manufactured from them. These include alcohols, acids, esters, fats, carbohydrates and proteins. The work forms a foundation for courses in physiological chemistry and agricultural analysis, and is especially planned for those majoring in chemistry or the other sciences. Those electing Course 51 are expected to elect Course 52.

5 class hours.

2 3-hour laboratory periods, credit, 8.

Professor CHAMBERLAIN and Mr. FANEUF.

Prerequisites, Chemistry 3 or 6, and Chemistry 27 for those majoring in chemistry.

52. **II. ORGANIC CHEMISTRY.** — For juniors; seniors may elect. A continuation of Course 51, dealing principally with compounds of the benzene series.

5 class hours.

2 3-hour laboratory periods, credit, 8.

Professor CHAMBERLAIN and Mr. FANEUF.

62. **III. ADVANCED QUANTITATIVE ANALYSIS.** — For juniors; seniors may elect. Advanced work on subjects as stated under Course 27, together with the analysis of insecticides or the analysis of soils and fertilizers.

1 class hour.

2 4-hour laboratory periods, credit, 5.

Professor WELLINGTON and Professor PETERS.

Prerequisite, Chemistry 27.

65. **III. PHYSICAL CHEMISTRY.** — For juniors; seniors may elect. A résumé of general chemistry from the viewpoint of physical chemistry, and the application of physical chemistry to agricultural chemistry.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Mr. SEREX and Mr. STURGIS.

Prerequisite, Chemistry 27.

76. **I. MILK AND BUTTER ANALYSIS.** — For seniors; juniors may elect. A study of milk and butter analytically.

1 class hour.

2 4-hour laboratory periods, credit, 5.

Professor PETERS and Mr. JULIAN.

Prerequisite, Chemistry 27.

77. **II. CATTLE FEED, WATER AND MISCELLANEOUS ANALYSIS.** — For seniors; juniors may elect. The analysis of cattle feeds and water, with interpretations. Other materials may be analyzed.

1 class hour.

2 4-hour laboratory periods, credit, 5.

Professor PETERS and Mr. JULIAN.

Prerequisite, Chemistry 27.

80. **I. PHYSIOLOGICAL CHEMISTRY.** — Seniors. This course is intended to be supplementary to Courses 51 and 52. To those who expect to take up scientific work in microbiology, botany, agronomy, animal husbandry, etc., and who have had Courses 51 and 52, it will give acquaintance with the chemistry of the physiological processes in plants and animals, by means of which some of the important organic compounds studied in Courses 51 and 52 are built up in the living organism or are used as food by it. In the lectures the study of food and nutrition as related to both human and domestic animals is the principal subject. In the laboratory experimental studies are made of the animal body and the processes and products of digestion, secretion and excretion.

3 class hours.

2 2-hour laboratory periods, credit, 5.

Professor CHAMBERLAIN and Mr. FANEUF.

87. **III. HISTORY OF CHEMISTRY.** — Seniors. An exposition of the development of chemical knowledge from the earliest times to the present. Although the entire history will be included, the larger portion of it will receive only brief mention in order that the questions of vital interest in modern life and industry may be studied at greater length. Particular attention will be given to the questions of plant and animal industry. Chemists are strongly advised to take this course.

3 class hours.

Credit, 3.

Professor WELLINGTON.

90. **II. SPECIAL WORK IN AGRICULTURAL CHEMICAL ANALYSIS.** — Seniors. The student is given a problem to solve either in analytical chemistry or related to the agricultural industries. This is to acquaint him with the methods used in research and with the literature, and show him how to handle problems in this field of chemistry when occasion arises.

6 or 10 laboratory hours, credit, 3 or 5.

Professor PETERS.

91. **III. SPECIAL WORK IN AGRICULTURAL CHEMICAL ANALYSIS.** — Seniors. As stated in Course 90.

10 laboratory hours, credit, 5.

Professor PETERS.

Prerequisite, Chemistry 90.

92. **II. SPECIAL WORK IN PHYSIOLOGICAL AND ORGANIC AGRICULTURAL CHEMISTRY.** — Seniors. In this course, as in Courses 90 to 95, the student will be able to give his attention primarily to one line of chemical study. To those whose tastes and interests are in connection with the organic and physiological problems of agricultural chemistry, many subjects of study present themselves, among which may be mentioned: proteins, carbohydrates, fats, organic nitrogenous compounds in fertilizers and soils and their relation to plants, the commercial production of alcohol from agricultural products, dyes, digestion and dietary studies, the chemical study of dairy products, etc.

6 or 10 laboratory hours, credit, 3 or 5.

Professor CHAMBERLAIN.

Prerequisites, Chemistry 51, 52 and 80.

93. **III. SPECIAL WORK IN PHYSIOLOGICAL AND ORGANIC AGRICULTURAL CHEMISTRY.** — Seniors. As stated under Course 92.

10 laboratory hours, credit, 5.

Professor CHAMBERLAIN.

Prerequisite, Chemistry 92.

94. **II. SPECIAL WORK IN PHYSICAL CHEMISTRY.** — Seniors. The field of agricultural chemistry offers many problems that have been attacked through the methods of physical chemistry; such, for example, are the hydrolysis of salts and of minerals and the absorption of salts and fertilizers by soils. Each student will select one line of work and follow it through the course, repeating some of the original work.

6 or 10 laboratory hours, credit, 3 or 5.

Mr. SEREX.

Prerequisite, Chemistry 65.

95. **III. SPECIAL WORK IN PHYSICAL CHEMISTRY.** — Seniors. As stated under Course 94.

10 laboratory hours, credit, 5.

Mr. SEREX.

Prerequisite, Chemistry 94.

Entomology.

Professor FERNALD, Professor CRAMPTON, Associate Professor REGAN.

The introductory Courses 26 and 27, taken together, present a comprehensive view of the relation of insects to man, particularly as crop pests. The most important pests are carefully studied, together with the methods for their control. Courses 50 and 51 are arranged for special study of the pests of any one line of agricultural or horticultural occupation, selected by the student according to his plan of future work, with the intent of making him thoroughly familiar with the pests he will meet in his selected work after graduation, and the means of controlling them. The remaining courses are for the training of men as State or experiment station entomologists; for those going into the care of trees, etc., on estates, or for cities and towns; and as entomological experts, for which the demand has been very large.

A recently erected building provides excellent lecture rooms and laboratories. The laboratories are provided with individual desks, equipped with microscopes and all needed apparatus of all kinds. Dissecting microscopes, binoculars, microtomes, photographic apparatus, glassware and reagents are available for use and electric light and gas are connected with each desk. Two laboratories, one for juniors and seniors, the other for graduate students, are thus equipped. A department library containing all the more important works on insects, supplemented by others on the subject in the main library, and by the private libraries of the professors, make available more than 25,000 books and pamphlets on this subject. In addition, all the current magazines are received and their files are accessible to every one. A card catalogue giving references to the published articles on different insects contains about 65,000 cards, and is probably the largest index of its kind in the world. Spray pumps, nozzles and spraying appliances of all kinds are in use in various parts of the courses, and a large collection of insecticides is accessible for study. Photographic rooms are specially prepared for the

photography of insects, and the greenhouses, gardens, orchards and the grounds of the college provide wide opportunities for the study, under natural conditions, of insect pests.

Elective Courses.

26. **II.** 27. **III.** GENERAL AND ECONOMIC ENTOMOLOGY. — For sophomores; juniors and seniors may elect. This course is planned to meet the needs of students who desire some knowledge of insects, but who cannot give more than two terms to the subject. It also serves as an introduction to the later courses for those who intend to follow entomology farther. It touches briefly upon the structure of insects so far as this is needed for such a course; deals with metamorphosis, classification to the larger groups, and discusses the most important methods and materials used for control. The greater part of the time is devoted to special study of the most important insect pests, particularly of New England, showing their modes of life, the injuries they cause, and the best methods of control. In this way the most serious pests of fruit trees, ornamental trees and shrubs, market-garden and greenhouse pests, those attacking field crops and those affecting animals and man, are treated. During the winter term and in the spring term until about the first of May instruction is given by lectures and recitations; from about the first of May field work takes the place of the lectures. In this part of the course the students are shown how to find and recognize the work of the various insect pests which may be accessible at that season of the year, and they also make and preserve a collection of insects.

3 class hours.

Credit, 3.

Professor FERNALD.

27. **III.** GENERAL AND ECONOMIC ENTOMOLOGY. — As stated under Course 26, **II.**

2 class hours till about May 1; thereafter 2 2-hour field periods. Credit, 2.

Professor FERNALD, Professor CRAMPTON and Associate Professor REGAN.

50. **I.** PESTS OF SPECIAL CROPS. — For juniors; seniors may elect. For students not majoring in entomology, and also for those majoring in entomology. The laboratory work is largely individual in this term. Accordingly, students majoring in subjects other than entomology, but who desire a more complete knowledge of the insects connected with their own major line of work, can obtain it here. A student majoring in floriculture, for example, will devote his laboratory time to a careful study of the insects injuring floricultural crops, learning how to recognize them and their work in their different stages, and the best methods for their control. Courses of this kind are available on the insects attacking field crops, market-garden crops, tree fruits, small fruits, shade trees and shrubs, flowers, forest trees, the domesticated animals and man. This work may be continued in the winter term also. (See 51, **II.**)

3 2-hour laboratory periods, credit, 3.

Professor FERNALD.

Prerequisites, Entomology 26 and 27.

51. **II.** PESTS OF SPECIAL CROPS. — As stated in 50, **I.**

3 2-hour laboratory periods, credit, 3.

Professor FERNALD.

Prerequisite, Entomology 50.

53. **I. INSECT MORPHOLOGY.** — For juniors; seniors may elect. For students majoring in entomology. The lectures of this course treat of the external and internal anatomy of insects, particularly of those characters used in identification, a knowledge of which is needed in the accompanying laboratory work. In the laboratory the external anatomy of the most important groups is studied, followed by the identification of insects of these groups, to show how the characters are made use of in learning the names of insects, and to teach the use of analytical keys.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Professor CRAMPTON.

Prerequisites, Entomology 26 and 27.

54. **II. INSECT CLASSIFICATION.** — For juniors; seniors may elect. For students majoring in entomology. Systematic identification of insects of various groups. Study of various entomological publications and methods of finding the literature on any insect.

3 2-hour laboratory periods, credit, 3.

Associate Professor REGAN.

Prerequisite, Entomology 53.

55. **III. ECONOMIC ENTOMOLOGY.** — For juniors; seniors may elect. Special studies on the most serious insect pests, their habits, nature of the injuries they cause and methods of control. In the lectures the composition, preparation and methods of application of the more important insecticides, their merits and defects, and studies of insecticide apparatus and other methods of control are treated. A portion of the laboratory time will be used in practical work on the topics taken up in the lectures.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Professor FERNALD, Professor CRAMPTON and Associate Professor REGAN.

Prerequisite, Entomology 54.

75. **III. FOREST AND SHADE-TREE INSECTS.** — For juniors; seniors may elect. The lecture work deals with the principles and methods of controlling insects which attack forests and forest products, shade trees, etc. The laboratory periods are devoted to a study of the more important species, their identification, biology and specific control measures. Field work will supplement laboratory study if time permits.

1 class hour.

3 2-hour laboratory or field periods, credit, 4.

Associate Professor REGAN.

Prerequisites, Entomology 26 and 27; 53 and 54 desirable.

76. **I. ADVANCED ENTOMOLOGY.** — For seniors. During this year studies of scale insects (coccidology), life histories of important pests, the preparation of bibliographies, methods of rearing, photography of insects, methods for experimental work and record keeping, and studies of the early stages of insects will be given. Insects as disease carriers, insect bionomics, and a study of the animals not insects with which entomologists are expected to deal, will also be included in this course.

2 class hours.

3 2-hour laboratory periods, credit, 5.

Professor FERNALD, Professor CRAMPTON and Associate Professor REGAN.

Prerequisite, Entomology 55.

77. **II. ADVANCED ENTOMOLOGY.** — As stated in Course 76, I.

3 2-hour laboratory periods, credit, 3.

Professor FERNALD, Professor CRAMPTON and Associate Professor REGAN.
Prerequisite, Entomology 76.

78. **III. ADVANCED ENTOMOLOGY.** — As stated in Course 76, I.

1 class hour.

3 2-hour laboratory or field periods, credit, 4.

Professor FERNALD, Professor CRAMPTON and Associate Professor REGAN.
Prerequisite, Entomology 77.

90. **II. EVOLUTION.** — For juniors; seniors may elect. In order to demonstrate the universal scope and operation of the laws of evolution, the course includes a brief sketch of the probable origin and evolution of matter as viewed in the light of modern physical and chemical research; the evolution of the solar system, leading to the formation of the earth; the changes in the earth, preparatory to the production of life; the physical and chemical basis of life; the probable steps in the formation of living matter, and the theories concerning it; the evolution of living things; the developmental history of man, and of the races of mankind, the evolution of human intelligence, languages, culture, institutions, etc., and man's probable future in the light of his past development. Especial consideration is given to the factors of evolution, the basic principles of heredity, sex-determination, variation and similar topics, with particular reference to their application to human welfare; and the recent contributions in the field of entomology to the advancement of our knowledge of these fundamental principles are briefly reviewed.

3 class hours.

Credit, 3.

Professor CRAMPTON.

Mathematics and Civil Engineering.

Professor OSTRANDER, Associate Professor MACHMER, Assistant Professor MOORE, Mr. PARKER.

The work of the freshman year is required. It is intended to furnish the necessary drill and groundwork needed for many of the scientific and practical courses of other departments. Thoroughness and accuracy are insisted upon. The advanced work in mathematics is taught from a practical standpoint, and many of its applications to other subjects are given. The courses in surveying and civil engineering are given to furnish the groundwork for a professional career. Special emphasis is given to the subjects bearing on highway construction and maintenance.

For drawing, a room on the north side is used for the draughting. It has draughting tables, T squares, scales, etc., for twenty students. Vernier protractors, parallel rules and steel T squares are available for precise work. A small room is devoted to blue-printing.

In surveying, the department has a considerable number of chains and tapes, two railroad compasses, a builder's level, two dumpy levels, two Y levels and two old levels used for teaching the adjustments. Six transits are available for student use. Two are provided with solar attachments. An omnimeter with vernier reading to ten seconds is available for geodetic work. A hand level, mining aneroid barometer, and prismatic compass are provided for reconnaissance work. A set of Gilmore's needles and a Fairbanks machine are used for cement testing.

Required Courses.

1. **I. HIGHER ALGEBRA.** — Freshmen. A brief review of radicals, quadratic equations, ratio and proportion, and progressions; graphs, binomial theorem, undetermined coefficients, summation of series, variation, continued fractions, determinants, permutations and combinations, logarithms, theory of equations. Reitz and Crathorne's "College Algebra."
5 class hours.

Credit, 5.

The DEPARTMENT.

2. **II. HIGHER ALGEBRA.** — As stated under Course 1.
2 class hours.

Credit, 2.

The DEPARTMENT.

3. **III. SOLID GEOMETRY.** — Freshmen. Theorems and exercises on the properties of straight lines and planes, dihedral and polyhedral angles, prisms, pyramids and regular solids; cylinders, cones and spheres; spherical triangles and the measurement of surfaces and solids. Wentworth and Smith's "Solid Geometry." Required unless accepted for admission.
3 class hours.

Credit, 3.

The DEPARTMENT.

5. **II. PLANE TRIGONOMETRY** (in charge of Department of Physics). — Freshmen. The trigonometric functions as lines and ratios; proofs of the principal formulas, transformations; inverse functions, use of logarithms; the applications to the solution of right and oblique triangles; practical applications. Bowser's "Elements of Plane and Spherical Trigonometry."
3 class hours.

Credit, 3.

Professor HASBROUCK and Associate Professor ROBBINS.

6. **III. MENSURATION AND COMPUTATION.** — Freshmen. The course includes a review of methods of computation, with special emphasis on short and abbreviated processes, together with methods of checking computations and of forming close approximations; use of slide rule. Also the graph, mensuration of plane and solid figures, weights and measures and elementary mechanism. Numerous practical problems are selected from such subjects as the following: the mathematics of woodworking; rough lumber; general construction; forestry methods in heights of trees; pulleys, belts and speeds; power and its transmission; dairying; agronomy; computation of areas from simple measurements.

2 class hours.

Credit, 2.

The DEPARTMENT.

Elective Courses.

26. **II. PLANE SURVEYING.** — For sophomores; juniors and seniors may elect. The elements of the subject, including the adjustment and use of the usual instruments. Textbook and lectures.
2 class hours.

Credit, 2.

The DEPARTMENT.

27. **III. PLANE SURVEYING.** — For sophomores; juniors and seniors may elect. As stated under Course 26. Includes field work.

3 2-hour laboratory periods, credit, 3.

The DEPARTMENT.

Prerequisite, Mathematics 26.

50. **I. ANALYTIC GEOMETRY.** — For juniors; seniors may elect. A discussion of the geometry of the line, the circle, conic sections, and the higher plane curves. Fine and Thompson's "Co-ordinate Geometry."

3 class hours.

Credit, 3.

The DEPARTMENT.

Prerequisites, Mathematics 1, 2, 3 and 5.

51. **II. DIFFERENTIAL AND INTEGRAL CALCULUS.** — For juniors; seniors may elect. A first course in the subject, with some of the more important applications. Granville's "Differential and Integral Calculus."

5 class hours.

Credit, 5.

The DEPARTMENT.

Prerequisites, Mathematics 1, 2, 3 and 5.

52. **III. INTEGRAL CALCULUS.** — For juniors; seniors may elect. A continuation of Course 51.

5 class hours.

Credit, 5.

The DEPARTMENT.

Prerequisite, Mathematics 51.

53. **II. ELEMENTARY STRUCTURES.** — For juniors; seniors may elect. An elementary course in roofs and bridges. Textbook and lectures.

3 class hours.

1 2-hour laboratory period, credit, 4.

The DEPARTMENT.

75. **I. HYDRAULICS AND SANITARY ENGINEERING.** — For seniors; juniors may elect. Hydrostatics, theoretical hydraulics, orifices, weirs, pipes, conduits, water supply, hydraulic motors, sewers and sewage treatment. Textbook and lectures.

5 class hours.

Credit, 5.

The DEPARTMENT.

76. **I. MATERIALS OF CONSTRUCTION, FOUNDATIONS AND MASONRY CONSTRUCTION.** — For seniors; juniors may elect. Textbook and lectures.

4 class hours.

1 2-hour laboratory period, credit, 5.

The DEPARTMENT.

77. **II. ROADS AND RAILROADS.** — For seniors; juniors may elect. Topographic and higher surveying, highway construction, earthwork, pavements and railroad construction. Textbook and lectures.

3 class hours.

Credit, 3.

The DEPARTMENT.

78. **III. ROADS AND RAILROADS.** — For seniors; juniors may elect. As stated under Course 77.

3 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

Prerequisite, Mathematics 77.

79. **I. APPLIED MECHANICS.** — Seniors. A course in applied mechanics, based on the calculus, with problems. Textbooks and lectures.
5 class hours.

Credit, 5.
The DEPARTMENT.

Prerequisites, Mathematics 51, 52.

Microbiology.

Professor MARSHALL, Associate Professor ITANO, Mr. HOOD, Mr. NEILL.

Three objectives are sought in the arrangement of the courses following: (1) An introductory course (50) needed in the general training of every college student. (2) An introductory course (50) followed by a specific course (as 80, 81, 82, 83), necessary to every student engaged in the Division of Agriculture, with which the specific course deals. (3) An introductory course (50) followed by Courses 51, 52, 75, 76, and 81, preparatory for students who are aiming to specialize in agricultural microbiology. (Courses 75, 76, and 81 are adapted to those having Course 50 only, and are also adapted to those majoring in microbiology).

The microbiological work is housed in a newly constructed building especially designed for it. There are 4 class laboratory rooms, 8 private laboratory rooms, 1 lecture room, 5 incubator rooms, 3 sterilizing rooms, 3 hood rooms, 3 washing rooms, 3 inoculating rooms, 3 weighing rooms, an animal room, a photographic and a dark room, a sub-basement refrigerator room, a library and 4 office rooms.

The class laboratory rooms are so arranged that individual desks are available for student use. Hot and cold water and gas connections are convenient for each desk; high-pressure steam and electric connections are also available. The building is well lighted and of sanitary construction; all the walls are of brick, and the building is fireproof.

The library is equipped with such books and current periodicals as are useful in the conduct of bacteriological work and investigations. Twenty-four scientific magazines are available regularly.

There are incubators, both electric and gas, hot-air sterilizers, ordinary steam sterilizers, autoclaves, an inspissator, blood-testing apparatus, vacuum apparatus, air-pressure apparatus, shaker, grinder, centrifugal machines, a water still of 5 gallons per hour capacity, Hoskins combustion furnace, a balopticon, complete microphotographic equipment, microscopes, microtome, and such other apparatus, glassware and chemicals as are needed for extensive and intensive work.

Elective Courses.

50. **I., II. and III. INTRODUCTORY AND GENERAL MICROBIOLOGY.** — For juniors; seniors may elect. Aims to provide elementary basis for microbial studies and interpretation, to enable students to pursue special pertinent courses which will serve as supports in practical electives or majors, and to

furnish students with such material as will be valuable in understanding public health problems. Three hours scheduled, five hours by arrangement.
2 class hours. 6 laboratory hours, credit, 5.

Professor MARSHALL, Associate Professor ITANO and Mr. NEILL.

51. **II. and III. MORPHOLOGICAL, CULTURAL AND PHYSIOLOGICAL MICROBIOLOGY.** — For juniors; seniors may elect. Types of micro-organisms, technic of handling, methods of culture and functions of micro-organisms are considered. This course is fundamental to all advanced and extended microbiological studies. One hour will be scheduled.

10 laboratory hours, credit, 5.

Associate Professor ITANO and Mr. NEILL.

52. **III. ADVANCED MORPHOLOGICAL, CULTURAL AND PHYSIOLOGICAL MICROBIOLOGY.** — For juniors; seniors may elect. The purpose of this course is to prepare the student for a more intimate knowledge of microbiological agricultural problems. To accomplish this object it is necessary to provide more advanced technic and methods of culture, together with a more extensive knowledge of micro-organisms and their functions. One hour will be scheduled.

10 laboratory hours, credit, 5.

Associate Professor ITANO and Mr. NEILL.

Prerequisite, Microbiology 50.

75. **II. AGRICULTURAL MICROBIOLOGY.** — For seniors; juniors may elect. This general comprehensive course is designed to cover in an elementary manner those subjects only which confront the student of general agriculture, — the microbiological features of air, water, sewage, soil, dairy, fermentations, food, vaccines, antisera, microbial plant infections, methods and channels of infections, immunity and susceptibility, microbial infections of man and animals, methods of control or sanitary and hygienic practices. One hour will be scheduled.

10 laboratory hours, credit, 5.

Professor MARSHALL, Associate Professor ITANO and Mr. NEILL
or Mr. HOOD.

Prerequisite, Microbiology 50.

76. **III. AGRICULTURAL MICROBIOLOGY.** — For seniors; juniors may elect. As stated under Course 75. One hour will be scheduled.

10 laboratory hours, credit, 5.

Professor MARSHALL, Associate Professor ITANO and Mr. NEILL
or Mr. HOOD.

Prerequisites, Microbiology 50 and 75.

80. **II. SOIL MICROBIOLOGY.** — For seniors; juniors may elect. Such subjects as the number and development of micro-organisms in different soils; the factors which influence their growth, food, reaction, temperature, moisture and aeration; the changes wrought upon inorganic and organic matter in the production of soil fertility, ammonification, nitrification and denitrification;

fixation of nitrogen symbiotically and non-symbiotically; methods of soil inoculation receive attention. One hour will be scheduled.

10 laboratory hours, credit, 5.

Associate Professor ITANO.

Prerequisite, Microbiology 50.

81. **I. HYGIENIC MICROBIOLOGY.** — For seniors; juniors may elect. An attempt will be made to select for this course certain material which should be the possession of every individual, and which is basic to public hygiene and sanitation, as applied to man and animals. The microbiology of water supplies, food supplies, vaccines, antisera or antitoxins; the channels by which micro-organisms enter the body, the influence of body fluids and tissues upon them, body reactions with micro-organisms (susceptibility and immunity); the micro-organisms of some of the most important infectious diseases, methods of control, including disinfectants and disinfection, antiseptics, antisepsis and asepsis, will be treated. One hour will be scheduled.

10 laboratory hours, credit, 5.

Professor MARSHALL and Mr. HOOD, or Associate Professor ITANO
and Mr. NEILL.

Prerequisite, Microbiology 50.

82. **I. DAIRY MICROBIOLOGY.** — For seniors; juniors may elect. Special emphasis will be placed upon milk supplies. The microbial content of milk, its source, its significance, its control; microbial taints and changes in milk; groups or types of organisms found in milk; milk as a carrier of disease-producing organisms; the value of straining, aeration, clarification, centrifugal separation, temperature, pasteurization; the abnormal fermentations of milk; bacteriological milk standards and their interpretation; ripening of milk and cream; the bacterial content of butter; a passing survey of the microbiology of cheeses; a study of special dairy products, as ice cream, condensed milk, artificial milk drinks (the products of microbial actions), represents a list of topics considered.

10 laboratory hours, credit, 5.

Professor MARSHALL and Mr. HOOD.

Prerequisite, Microbiology 50.

83. **I. FOOD MICROBIOLOGY.** — For seniors; juniors may elect. A study of the principles of food preservation, and food preservation by means of drying, canning, refrigerating and addition of chemicals, will be pursued. Food fermentations, as illustrated by bread, pickles, sauerkraut, ensilage, vinegar, wine, etc., will be examined. Decomposition of foods, as may be seen in meat, oysters, fish, milk, etc., as well as diseased and poisonous foods, will receive consideration. Contamination of food supplies by means of water, sewage, handling, exposure, diseased persons, etc., is of especial significance, and will be demonstrated by laboratory exercises. Laboratory inspection of foods is now a subject of great import and will be given attention. One hour will be scheduled.

10 laboratory hours, credit, 5.

Professor MARSHALL and Mr. HOOD.

Prerequisite, Microbiology 50.

SPECIAL COURSES FOR WOMEN.

1. **I. ELEMENTARY MICROBIOLOGY.** — For freshmen. The course will be devoted to the various types of micro-organisms, their distribution in nature and their characterization. Such methods as are essential for examination, manipulation and culturing will be studied and employed.

6 laboratory periods, credit, 3.

Associate Professor ITANO and Mr. NEILL.

In place of Military 1, tactics; Military 4, drill; fall term, freshmen.

3. **III. ELEMENTARY MICROBIOLOGY.** — For freshmen. Continuation of 1.

4 laboratory periods, credit, 2.

Associate Professor ITANO and Mr. NEILL.

In place of Military 3, tactics; Military 6, drill; spring term, freshmen.

25. **I. PERSONAL HYGIENE.** — For sophomores. Such subjects as the hygiene of the mouth and teeth, the gastro-intestinal tract, food, the skin, respiration apparatus, ear, eye and nervous system are reviewed. The value of bathing, clothing, physical exercise, etc., are considered. Attention will be given to emergencies, accidents of "first aid," and such other matters as usually fall within this category.

2 class hours, credit, 2.

Professor MARSHALL.

In place of Military 27, tactics; Military 28, drill; fall term, sophomores.

27. **III. SANITARY SCIENCE.** — For sophomores. The usual topics of sanitary science, as ventilation, heating, plumbing, water supply, sewage disposal, food control and communicable diseases, will be treated wholly from the standpoint of individual and public health control.

2 class hours, credit, 2.

Professor MARSHALL.

In place of Military 27; Military 30; spring term, sophomores.

Physics.

Professor HASBROUCK, Associate Professor ROBBINS, Mr. THOMPSON,¹ Mr. BURT.

The fundamental and basic importance of the laws and phenomena of physics makes necessary no explanation of the introduction of this subject into the curriculum of an agricultural college. The logical development of the subject emphasizes the importance of physics as a science in itself. Special emphasis is laid, however, on the correlation of the principles studied with the sciences of agriculture, botany, chemistry and zoölogy, thus furnishing an extra tool by use of which the student's work in all the subjects may be more effective.

¹ Second and third terms, 1920.

In Courses 25, 26 and 27 the subject-matter is presented with the idea of its special application primarily in the work in agriculture and general science. The full year's work is advised for all students continuing work specifically in the Division of Science. Courses 25 and 26 are required of all students. Course 29 is advised for students expecting to do special work in farm mechanics or general farm practice. The subject-matter is especially selected and arranged for its practical application rather than its theoretical development. Courses 50, 51 and 52 are advised for students in chemistry, general biology, microbiology and general science. The subject-matter is selected, and the courses developed, with the idea of making the student proficient in laboratory manipulation. Sufficient theory is given in connection with the work to enable the student to apply the knowledge and practice thus gained in the departments indicated above.

The department has at its command a building on the east campus, containing a general lecture room and laboratory for sophomore work, a laboratory for junior work, and in the basement one small laboratory for quantitative work in light measurement. There is also in the basement a fairly well-equipped shop for the repair and construction of apparatus used in the department work. The usual apparatus for the demonstration in the lecture room is in the possession of the department. The laboratory equipment is such as to enable the department to offer qualitative work in mechanics, heat, electricity and light.

Required Courses.

25. **I. GENERAL PHYSICS.** — Sophomores. Mechanics of solids and fluids. This course includes statics, with equilibrium of rigid bodies, work, energy and friction; kinetics, considering rectilinear motion and motion in a curved path; harmonic motion; rotation of rigid bodies, including kinematics of rotation; liquids and gases, with properties of fluids at rest and in motion; properties of matter and its internal forces, including elasticity, capillarity, surface tension.

3 class hours.

1 2-hour laboratory period, credit, 4.

Professor HASBROUCK and Associate Professor ROBBINS.

26. **II. ELECTRICITY AND MAGNETISM.** — Sophomores. The work in electricity includes such subject-matter as magnetism, electrostatics, electric currents with their production, chemical, heating and mechanical effects; battery cells, measurement of voltage, current flow and resistance, motors and generators.

2 class hours.

1 2-hour laboratory period, credit, 3.

Associate Professor ROBBINS.

Elective Courses.

27. **III. HEAT AND LIGHT.** — For sophomores; juniors and seniors may elect. Thermometry, expansion, colorimetry and specific heat, transmission of heat, changes of state, radiation and absorption. Wave theory of light, optical instruments, analysis of light, color, interference, diffraction, polarization.

4 class hours.

1 2-hour laboratory period, credit, 5.

Professor HASBROUCK and Associate Professor ROBBINS.

29. **III. INDUSTRIAL ELECTRICITY.** — For sophomores; juniors and seniors may elect. Wiring and testing of commercial equipment, such as storage cells, dynamos, motors, engine ignitors and distributors, heaters, transformers, etc. Laboratory work, accompanied by notes and required reading. Elective only by arrangement with instructor.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Associate Professor ROBBINS.

Prerequisite, Physics 26.

50. **I. ELECTRICITY, HEAT AND LIGHT.** — For juniors; seniors may elect.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Mr. THOMPSON.

Prerequisite, Physics 27.

51. **II. ELECTRICITY, HEAT AND LIGHT.** — For juniors; seniors may elect. Continuation of Course 50.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Mr. THOMPSON.

Prerequisite, Physics 50.

52. **III. ELECTRICITY, HEAT AND LIGHT.** — For juniors; seniors may elect. Continuation of Courses 50 and 51.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Mr. THOMPSON.

Prerequisite, Physics 51.

Veterinary Science.

Professor PAIGE, Associate Professor GAGE.

The courses in veterinary science have been arranged to meet the needs (1) of students who propose following practical agriculture; (2) of prospective students of human and veterinary medicine; and (3) of teachers and laboratory workers in the biological sciences.

The department occupies a modern laboratory and hospital stable, built in accordance with the latest principles of sanitation. Every precaution has been taken in the arrangement of details to prevent the spread of disease, and to provide for effective heating, lighting, ventilation and disinfection.

The main building contains a large working laboratory for student use, and several small private laboratories for special work. There is a lecture hall, a museum, a demonstration room, a photographing room and a workshop. The hospital stable contains a pharmacy, an operating hall, a post-mortem and dissecting room, a poultry section, a section for cats and dogs, and 6 sections, separated from each other, for horses, cattle, sheep and swine. The laboratory equipment consists of a dissectible Auzoux model of the horse and Auzoux models of the foot and the leg, showing the anatomy and the diseases of every part. The laboratories also have modern, high-power microscopes, microtomes, incubators and sterilizers, for work in every department of veterinary science, including pathology, serology and parasitology. There are skeletons of the horse, the cow, the sheep, the dog and the pig, and a growing collection of anatomical and pathological specimens. The lecture room is provided with numerous maps, charts and diagrams.

Elective Courses.

50. **I. VETERINARY HYGIENE AND STABLE SANITATION.** — For juniors; seniors may elect. This course is intended to familiarize the student with the relation of water, food, air, light, ventilation, care of stables, disposal of excrement, individual hygiene, etc., to the prevention of disease in farm animals. 5 class hours.

Credit, 5.

Professor PAIGE.

75. **I. GENERAL VETERINARY PATHOLOGY. MATERIA MEDICA AND THERAPEUTICS.** — For juniors; seniors may elect. In this course such fundamental and general pathological conditions are studied as inflammation, fever, hypertrophy, atrophy, etc., a knowledge of which is essential in the diagnosis, prevention and treatment of disease. The course in pathology is followed by one in materia medica and therapeutics, dealing with the origin, preparation, pharmacology, pharmacy, administration and therapeutic use of the more common drugs. Poisonous plants and symptoms and treatment of plant poisoning are also considered.

5 class hours.

Credit, 5.

Professor PAIGE.

51. **II. COMPARATIVE (VETERINARY) ANATOMY.** — For seniors; juniors may elect. The anatomy of the horse is studied in detail, and that of other farm animals compared with it where differences exist. This course is essential for those students wishing to elect Course 76.

5 class hours.

Credit, 5.

Professor PAIGE.

76. **II. THEORY AND PRACTICE OF VETERINARY MEDICINE; GENERAL, SPECIAL AND OPERATIVE SURGERY.** — For seniors; juniors may elect. A course intended to familiarize the student with the various medical and surgical diseases of the different species of farm animals. Particular attention is given to diagnosis and first-aid treatment. The student is taught the technique of simple surgical operations that can with safety be performed by the stock owner. Lectures, demonstrations and practice. This course should be taken in conjunction with Course 51.

5 class hours.

Credit, 5.

Professor PAIGE.

Prerequisite, Veterinary 75.

78. **I. ESSENTIALS OF GENERAL PATHOLOGY.** — For seniors; juniors may elect. This course is planned to introduce the student to some of the essential anatomical, histological and general physiological phenomena essential to the understanding of some of the simple general pathological conditions found in domestic animals. Some of the common methods of diagnosis will be considered in the laboratory. The various chemical and biological reactions and tests will be presented from the standpoint of pure science, showing applications of chemistry and biology. The course will serve to liberally educate and stimulate in the student of agriculture the appreciation of some of the methods

used in animal pathology for detecting and controlling some of the more common animal diseases. Lectures, demonstration and laboratory work.

2 3-hour laboratory periods, credit, 3.

Associate Professor GAGE.

79. **II. ESSENTIALS OF GENERAL ANIMAL PATHOLOGY.**—For seniors; juniors may elect. This is a continuation of Course 78, and is devoted to a study of some of the common pathological conditions by means of prepared sections, the aim being to demonstrate to the student abnormal animal histological structures commonly observed when material from various cases of animal diseases is prepared for microscopical study. Some of the biological products used in protecting animals against disease will be considered.

2 3-hour laboratory periods, credit, 3

Associate Professor GAGE.

Prerequisite, Veterinary 78.

80. **III. ESSENTIALS OF GENERAL ANIMAL PATHOLOGY.**—For seniors; juniors may elect. As stated in Courses 78 and 79.

2 3-hour laboratory periods, credit, 3.

Associate Professor GAGE.

Prerequisite, Veterinary 79.

85. **I. AVIAN PATHOLOGY.**—For seniors; juniors may elect. A course in poultry diseases. The object of this course is to present information concerning the common diseases of poultry, their etiology, diagnosis and prevention. The work will consist of a systematic study of the diseases of the alimentary tract, liver and abdominal region, followed by a study of the diseases of the respiratory system, circulation and kidneys. The important disease-producing external and internal parasites will be considered; also diseases of the skin and reproductive organs. Lectures and demonstrations.

2 3-hour laboratory periods, credit, 3.

Associate Professor GAGE.

86. **II. AVIAN PATHOLOGY.**—For seniors; juniors may elect. As stated under Course 85, also devoted to the study of some of the special diseases of poultry. Recent methods used in the control of these diseases will be considered and opportunity offered the student for demonstrating various disease processes by means of prepared slides. Lectures, demonstrations and laboratory work.

2 3-hour laboratory periods, credit, 3.

Associate Professor GAGE.

Prerequisite, Veterinary 85.

87. **III. AVIAN PATHOLOGY.**—For seniors; juniors may elect. As stated under Courses 85 and 86.

2 3-hour laboratory periods, credit, 3.

Associate Professor GAGE.

Prerequisite, Veterinary 86.

Zoölogy and Geology.

Professor GORDON, Dr. ABBOTT.

The elective courses in zoölogy and geology in practice generally stand as offerings available to students who wish either to supplement their work in other departments or to continue their work in zoölogy or geology. They have definite objectives, either as supporting subjects or as courses designed to enlarge the student's knowledge in the subject pursued.

The building occupied jointly by the department of entomology and the department of zoölogy and geology has for the work in zoölogy and geology spacious laboratories equipped with gas, compound microscopes and the accessories needed for study, research and demonstration in these subjects. There are two commodious lecture rooms, used jointly by the two departments. The Zoölogical Museum has a representative collection of several thousand specimens of animals, and is drawn upon for material illustrating the various courses. The curator is Professor Gordon.

ZoöLOGY.

Required Course.

25. **I. PRINCIPLES OF ZOÖLOGY.** — Sophomores.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Professor GORDON and Dr. ABBOTT.

Elective Courses.

27. **III. ELEMENTS OF MAMMALIAN ANATOMY.** — Sophomores; juniors and seniors may elect.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor GORDON.

50. **I. SYNOPTIC INVERTEBRATE ZOÖLOGY.** — Juniors; seniors may elect.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. ABBOTT.

Prerequisite, Zoölogy 25.

51. **II. SYNOPTIC INVERTEBRATE ZOÖLOGY.** — Juniors; seniors may elect. Continuation of Course 50.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. ABBOTT.

Prerequisite, Zoölogy 50.

52. **III. SYNOPTIC INVERTEBRATE ZOÖLOGY.** — Juniors; seniors may elect. Continuation of Course 51.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. ABBOTT.

Prerequisite, Zoölogy 51.

53. **I. ELEMENTS OF MICROSCOPIC TECHNIQUE.** — Juniors; seniors may elect.
3 2-hour laboratory periods, credit, 3.
Professor GORDON.

54. **II. ELEMENTS OF HISTOLOGY.** — Juniors; seniors may elect.
3 2-hour laboratory periods, credit, 3.
Professor GORDON.

Prerequisite, Zoölogy 53.

55. **III. ELEMENTS OF HISTOLOGY.** — Juniors; seniors may elect.
3 2-hour laboratory periods, credit, 3.
Professor GORDON.

Prerequisite, Zoölogy 54.

58. **II. CONSERVATIONAL ZOÖLOGY.** — Juniors; seniors may elect. For students who are interested in the conservation of wild life, especially the natural fauna of the State. Not offered for the year 1919-20.
2 class hours. 1 2-hour laboratory period, credit, 3.
The DEPARTMENT.

75. **I. SPECIAL ZOÖLOGY.** — Juniors, seniors, graduates and others may apply for such special work as they are qualified to undertake.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

76. **II. SPECIAL ZOÖLOGY.** — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

77. **III. SPECIAL ZOÖLOGY.** — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

78. **II. ORNITHOLOGY.** — Juniors, seniors and others. The taxonomic characters, migrations and distribution of the birds.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

79. **III. ECONOMIC AND FIELD ORNITHOLOGY.** — A review and study in the field of the food and other habits of Massachusetts birds.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

GEOLOGY.

Required Course.

2. **II. AGRICULTURAL GEOLOGY.** — Freshmen.
2 class hours. Credit, 2.
Professor GORDON.

Elective Course.

27. **III. GENERAL GEOLOGY.** — Sophomores; juniors and seniors may elect.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor GORDON.

DIVISION OF THE HUMANITIES.

Professor SPRAGUE.

Economics and Sociology.

Professor SPRAGUE.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

The courses in economics and sociology are planned with the purpose of giving the student that knowledge and understanding of the important factors and problems in this field of study and life which every active citizen and educated man ought to have.

Elective Courses.

26. **II. CIVILIZATIONS, ANCIENT AND MODERN.** — For sophomores; others may elect. This course studies the evolutionary origin and history of man; characteristics of primitive man, departure from the animal status and beginnings of civilization; origin and development of industries, arts and sciences; the evolution of languages, warfare, migrations and social institutions; a study of the powerful natural and human forces that have brought man from the early stages to modern development; characteristic features of the leading civilizations and races of ancient and modern times; beneficial and dangerous factors in American life in view of the history of human civilization. 5 class hours.

Credit, 5.

Professor SPRAGUE.

50. **II. BUSINESS AND INDUSTRY.** — For juniors and seniors. The forms, organization, administration and labor problems of business. This course is devoted to the following subjects: methods of organizing, financing and administering corporations and partnerships; forms of business administration, wholesaling, jobbing, retailing, advertising, credits and collections; systems of industrial remuneration for wage earners, co-operation and preserving industrial peace; problems concerned with protective legislation for workmen and employers, sweated industries, prison labor, child labor and industrial education. 5 class hours.

Credit, 5.

Professor SPRAGUE.

51. **I. INTRODUCTION TO ECONOMIC PRINCIPLES AND PROBLEMS.** — For juniors. This course is devoted to the study of the following subjects: definitions of economic terms, such as wealth, capital, value, etc.; factors of production, exchange and consumption; principles of economic production, supply and demand, diminishing returns, division of labor, productive organization, concentration of capital and labor, trust and monopoly problems, public control of production and distribution; principles of exchange, theories of value, money and its problems; international trade, tariff and free trade theories, American merchant marine, reciprocity, and trade treaties; forms of income, wages, interest, rent, profits and the forces which govern them; principles of

spending, economy, luxury, conservation of individual and national resources; principles and agencies for saving, investments, banks, building associations, insurance of all kinds; schemes for social organization; socialism, communism, industrial democracy. Textbook and readings.
5 class hours.

Credit, 5.
Professor SPRAGUE.

75. I. SOCIAL INSTITUTIONS AND SOCIAL REFORMS. — For seniors; juniors by permission. This course is devoted to the study of the social institutions, such as the family, the State, property, religions; and to such current problems as eugenics, race suicide, divorce, crime and delinquent classes, prison reform, prevention and treatment of dependents and defectives, poverty, its causes and preventions; constructive modern social reform movements for insurance of wage earners, protection of childhood, assurance of safety, health and play time for all classes. The correctional and charitable institutions of Massachusetts will be studied in considerable detail.
5 class hours.

Credit, 5.
Professor SPRAGUE.

77. III. PUBLIC FINANCE, TAXATION, MONEY AND BANKING. — For seniors. This course studies systems and problems of taxation as they are found in Europe and America; objects for spending public revenue; public debts and methods of organizing them; systems of money and currency problems of America; types, methods and functions of banks; economic and financial crises and depressions in the United States; modern war finance. Readings and lectures.
5 class hours.

Credit, 5.
Professor SPRAGUE.

History and Government.

Elective Courses.

50. III. GOVERNMENT. — For juniors; seniors may elect. This course will cover subjects as follows: forms and working methods of the governments of Great Britain, Germany, France, Russia, Switzerland, New Zealand and Canada; historic types and theories of government; forms and methods of Federal, State and local governments in America; progress and problems of democracy and new reform movements in organization and administration; new tendencies towards social legislation and extension of governmental control over broader interests of the people.
5 class hours.

Credit, 5.
Professor SPRAGUE.

75. II. HISTORY OF NEW ENGLAND. — For seniors; juniors may elect. Treating New England as a geographical and political unit, this course aims to give a survey of its religious, social, economic and political history. The development of its institutions, the growth of its industries, the spread of its population to other sections of the country, its influence upon national character and politics are phases of the subject which will be discussed. Assigned readings and theses will be required.
3 class hours.

Credit, 3.

Languages and Literature.

Professor LEWIS, Professor PATTERSON, Professor MACKIMMIE, Associate Professor NEAL, Associate Professor ASHLEY, Assistant Professor PRINCE, Assistant Professor JULIAN, Mr. RAND, Miss GOESSMANN.

ENGLISH.

Required Courses.

1. **I.** 2. **II.** 3. **III.** ENGLISH. — Freshmen. Composition. Intended to teach straight thinking, sound structure, clear and correct expression. Lectures, recitations, theme writing and conferences.

3 class hours each term. Credit, 3 each term.

Associate Professor NEAL, Assistant Professor PRINCE and Mr. RAND.

25. **I.** 26. **II.** 27. **III.** ENGLISH. — Sophomores. A general reading course in English literature.

2 class hours each term. Credit, 2 each term.

Professor LEWIS and Miss GOESSMANN.

Elective Courses in English Language and Literature.

The elective courses in English fall into two groups. Both groups are intended to increase the student's understanding and appreciation of literature. Group one (Courses 50 to 58), besides introducing the student to individual writers, will emphasize the life and thought of the times. Group two (Courses 75, 79 and 80) will emphasize form-characteristics and the artistic quality or historical development of literary types.

50. **I.** ENGLISH POETRY OF THE ROMANTIC PERIOD (1921-22). — This course alternates with course 53. For juniors; seniors may elect. A course in history, appreciation and understanding. Some of the writers studied are Gray, Goldsmith, Burns, Scott, Wordsworth, Coleridge, Byron, Keats and Shelley.

3 class hours.

Credit, 3.

Professor PATTERSON.

51. **II.** ENGLISH POETRY IN THE NINETEENTH CENTURY. — This course alternates with Course 54. For juniors; seniors may elect. In general, this course is like Course 50. Tennyson, Browning, Mrs. Browning, Arnold, Clough, the Rossettis, Morris and Swinburne are among the writers to be studied.

3 class hours.

Credit, 3.

Professor LEWIS.

57. **III.** ENGLISH POETRY IN THE NINETEENTH CENTURY. — This course alternates with Course 58. For juniors; seniors may elect. As stated under Course 51.

2 class hours.

Credit, 2.

Professor LEWIS.

52. **III. ENGLISH WRITERS FROM MILTON TO POPE.** — For juniors; seniors may elect. A survey course that will emphasize the leading writers, literary currents and the thought of the period. Some of the writers studied are Milton, Dryden, Addison, Swift and Pope.

3 class hours.

Credit, 3.

Professor PATTERSON.

53. **I. ENGLISH PROSE OF THE ROMANTIC PERIOD.** — For juniors; seniors may elect. A course in English prose paralleling Course 51. Some of the writers studied are Goldsmith, Coleridge, Lamb, DeQuincey and Hazlitt.

3 class hours.

Credit, 3.

Professor PATTERSON.

54. **II. ENGLISH PROSE IN THE NINETEENTH CENTURY (1921-22).** — For juniors; seniors may elect. This course parallels Course 51. Among the writers considered will be Macaulay, Carlyle, Ruskin, Newman and Arnold.

3 class hours.

Credit, 3.

Professor LEWIS.

58. **III. ENGLISH PROSE IN THE NINETEENTH CENTURY (1921-22).** — For juniors; seniors may elect. As stated under Course 54.

2 class hours.

Credit, 2.

Professor LEWIS.

55. **II. AMERICAN LITERATURE.** — For juniors; seniors may elect. Intended to give a general survey of literature in America, especially in the nineteenth century, with an introduction to the work of the best known writers, and with especial attention to the relations between national life and history and national thought as expressed in literature. The usual authors — Irving, Cooper, Bryant, Poe, Longfellow, Emerson, Hawthorne, Whittier, Parkman, Lowell, Holmes, Whitman, Lanier — will be discussed, and attention will be given to southern and western authors. Present writers and tendencies will also receive some notice.

3 class hours.

Credit, 3.

Assistant Professor PRINCE.

56. **III. AMERICAN LITERATURE.** — For juniors; seniors may elect. As stated under Course 55.

2 class hours.

Credit, 2.

Assistant Professor PRINCE.

Prerequisite, English 55.

60. **I. THE LITERATURE OF RURAL LIFE.** — For juniors; seniors may elect. A critical and appreciative study of writers, both in prose and poetry, who have interpreted nature from the viewpoint of the lover of country life, and those who have idealized agriculture, horticulture and other rural pursuits, together with those who have upheld as an ideal the development of a rural environment in cities.

3 class hours.

Credit, 3

Miss GOESSMANN.

61. **II. THE LITERATURE OF RURAL LIFE.** — For juniors; seniors may elect. As stated under Course 60.

2 class hours.

Credit, 2.

Miss GOESSMANN.

Prerequisite, English 60.

75. **III. PROSE FICTION.** — The short story or the novel. For seniors; juniors may elect. Readings, reports and discussions. Texts (short story): Neal's "Short Stories in the Making" and "To-day's Short Stories Analyzed."

3 class hours or library equivalents.

Credit, 3.

Associate Professor NEAL.

79. **II. THE DRAMA.** — For seniors; juniors may elect. A cursory survey of early English drama, its origin, forms and meaning, will be followed by a careful study of Shakespeare. Four of his plays will be analyzed in detail, and many others will be read and discussed.

3 class hours.

Credit, 3.

Mr. RAND.

80. **III. THE DRAMA.** — For seniors; juniors may elect. The course will trace the development of modern drama, especial attention being given to plays by Congreve, Goldsmith, Sheridan, Robertson, Jones, Pinero, Fitch, Shaw, Moody and Ibsen.

2 class hours.

Credit, 2.

Mr. RAND.

APPLIED ENGLISH — RURAL JOURNALISM.

The courses in applied English and rural journalism have two chief aims: first, to turn the student's attention toward matters of contemporary concern, thus emphasizing the vital connection of thought and expression with citizenship and establishing a stimulating "contact" between the subject and the affairs of daily life; second, to provide training for students who may wish to enter journalism (especially agricultural or industrial journalism or non-urban newspaper work), or who are preparing for the numerous other vocations in which acquaintance with newspaper practices and requirements are of value. All of the courses afford constant practice in writing. Clearness of thought and expression, accuracy of statement, discrimination of the important from the unimportant, and interest and vigor of presentation are sought. So far as conditions permit, instruction is largely individual.

Courses 50 and 51 deal with the applications of the fundamental subjects of exposition and of narration and description. Course 52 provides more general practice in the same subjects, with their application to the purposes of the various kinds of periodical publications as a standard. Courses 53, 54 and 55 apply the principles of composition, and of significance and interest, to the reporting of fact. Courses 77, 78 and 79 provide reading in American history or in current events, and practice the student in commenting upon or interpreting topics of timely interest. Courses 80, 81 and 82 are temporarily withheld, the critical shortage of paper still compelling newspapers to extreme economy of space and even to reductions in size.

The newsroom, or laboratory, for the courses in applied English and journalism is equipped with typewriting machines; copytables; representative newspapers, reviews, agricultural papers and trade journals concerning journalism and writing; selected books on journalism; a small collection of yearbooks and other reference books; and a considerable "morgue" of indexed pamphlets, bulletins and clippings. The newsroom and office are in the recently completed Stockbridge Hall, near the library of the Division of Agriculture.

Elective Courses.

50. **I. ADVANCED COMPOSITION: EXPOSITION.** — For juniors; seniors may elect. Advanced composition; planning expository thought; expository structure; specimens, including contemporary articles from farm and rural life publications; some bulletin writing, including presentation of technical information for nontechnical readers.

3 class hours, or laboratory equivalents.

Credit, 3.

Associate Professor NEAL.

51. **II. ADVANCED COMPOSITION: NARRATION AND DESCRIPTION.** — For juniors; seniors may elect. The fundamental elements of style, word-choice, diction, sentence form and paragraph types. Description of persons, places, objects, industries and productional processes, the temper and characteristic aspects of public gatherings, moods, behavior and character-sketching. Narration of incident, sustained action, events in series and the like, as in biography, dramatic situation, history and fiction. [Not given in 1919-20.]

3 class hours, or laboratory equivalents.

Credit, 3.

Associate Professor NEAL.

52. **III. ADVANCED COMPOSITION: MAGAZINE WRITING.** — Presenting rural life and such other subjects as the student may elect, in form and manner suitable for use in farm journals, magazines and similar mediums.

3 class hours, or laboratory equivalents.

Credit, 3.

Associate Professor NEAL.

53. **I. 54. II. 55. III. NEWS-GATHERING AND NEWS-WRITING.** — For juniors; seniors may elect. The foundation aims and conceptions of journalism; reporting. Central purpose, to develop ability to pick out essentials from inessentials, perceive elements of interest, and present facts which appeal to the reader. Courses 53, 54 and 55 are suited to nonmajoring students whose vocation may require the popular presentation of technical or other information; *e.g.*, extension workers, county agents, agricultural-school instructors, experiment-station editors, survey and other social-service workers, men engaged in sociological or economic investigations, landscape architects and civil and sanitary engineers.

6 laboratory hours or class equivalents, credit, 3.

Associate Professor NEAL.

77. **I. 78. II. 79. III. EDITORIAL MATERIALS AND METHODS.** — For seniors; juniors may elect. Readings, quizzes, reports and personal conferences; American history or current events; reading of daily papers and

weekly reviews or rural-life periodicals; writing of editorial articles. Recommended to nonmajoring students who desire practice in discovering the significant aspects of matters of public attention and in effectively expressing comment thereon. Text, Neal's "Editorials and Editorial Writing." [Not given in term I., 1919-20.]

6 laboratory hours or class equivalents, credit, 3.

Associate Professor NEAL.

80. **I. 81. II. 82. III.** ADVANCED JOURNALISTIC PRACTICE. — Seniors. Preparation, editing and publication in a newspaper of a rural-life page. [Not given in 1919-20.]

8 or 10 laboratory hours, credits, 4 or 5.

Associate Professor NEAL.

PUBLIC SPEAKING.

Required Course.

1. **I., II. and III.** PUBLIC SPEAKING. — Freshmen. Freshman public speaking is required in the first, second or third term, at the option of the instructor. The course is concerned with the actual problems which confront the man who would speak convincingly and persuasively. Much attention, therefore, is given to the preparation and delivery of extempore speeches. Textbook, Robinson's "Effective Public Speaking," supplemented by class work and discussions. First, second or third terms, as directed.

1 class hour.

Credit, 1.

Assistant Professor PRINCE, Assistant Professor PATTERSON and
Mr. RAND.

Elective Courses.

50. **I.** ARGUMENTATION. — For juniors; seniors may elect. The course aims to present the fundamental principles of argumentation as applied to oral and written discourse, and intends to develop in the student power to handle argument convincingly and persuasively. Lectures, discussions of leading questions of the day, practice in brief-drawing and the writing of forensics. Textbook, Foster's "Argumentation and Debating." The course is recommended for those who desire to enter the intercollegiate debates.

3 class hours.

Credit, 3.

Assistant Professor PRINCE.

Prerequisites, Public Speaking, 1, 2 or 3.

51. **II.** OCCASIONAL ORATORY. — For juniors; seniors may elect. The course involves a study of the elements of vocal expression and action; speeches on assigned subjects; prescribed reading; the preparation and delivery of several formal orations. Textbook, Shurter's "The Rhetoric of Oratory." The course is recommended for those who wish to enter the Flint contest.

3 class hours.

Credit, 3.

Assistant Professor PRINCE.

Prerequisites, Public Speaking 1, 2 or 3.

French and Spanish.

Professor MACKIMMIE, —.

The aim of the courses in French and Spanish is to give the student a practical knowledge of these languages for the purpose of wider reading and research, to introduce him to some of their treasures in art and science, and through the literature to acquaint him with the people. In the elementary courses as much time as possible is given to oral work, to develop a speaking, as well as a reading, knowledge of the tongue.

FRENCH.

Required Courses.

1. **I.** 2. **II.** 3. **III.** **ELEMENTARY FRENCH.** — Freshmen; open upon arrangement to other students. The essentials of grammar are rapidly taught and will be accompanied by as much reading as possible. This course is required of freshmen presenting German for entrance who do not continue that language and have not studied French.

3 class hours each term.

Credit, 3 each term.

4. **I.** 5. **II.** 6. **III.** **INTERMEDIATE FRENCH.** — Freshmen; open upon arrangement to other students. Training for rapid reading. The reading of a number of short stories, novels and plays; composition, reports on collateral reading from periodicals and scientific texts in the library.

3 class hours each term.

Credit, 3 each term.

Professor MACKIMMIE.

Prerequisite, required of freshmen who present two years of French for entrance and do not take German.

Elective Courses.

25. **I.** **INTERMEDIATE FRENCH.** — For sophomores; open upon arrangement to other students. Training for rapid reading; the reading of a number of short stories, novels and plays; readings from periodicals and scientific texts in the library.

3 class hours.

Credit, 3.

Professor MACKIMMIE.

Prerequisites, French 1, 2 and 3.

26. **II.** **INTERMEDIATE FRENCH.** — For sophomores; open upon arrangement to other students. As stated under Course 25.

3 class hours.

Credit, 3.

Professor MACKIMMIE.

Prerequisite, French 25.

27. **III.** **INTERMEDIATE FRENCH.** — For sophomores; open upon arrangement to other students. As stated under Course 25.

3 class hours.

Credit, 3.

Professor MACKIMMIE.

Prerequisite, French 26.

28. **I. ADVANCED FRENCH.** — For sophomores; open upon arrangement to other students. A reading course. Balzac's "Eugénie Grandet" and "Le Père Goriot," and other masterpieces of the nineteenth century; Brunetière's "Honoré de Balzac" and Harper's "Masters of French Literature;" readings in the library and written reports.

3 class hours.

Credit, 3.

Prerequisites, French 4, 5 and 6.

29. **II. ADVANCED FRENCH.** — For sophomores; open upon arrangement to other students. As stated under Course 28.

3 class hours.

Credit, 3.

Prerequisites, French 4, 5 and 6.

30. **III. ADVANCED FRENCH.** — For sophomores; open upon arrangement to other students. General view of the history of French literature; Kastner and Atkins' "History of French Literature." Representative works of the important periods will be studied in class. Outside reading will be required.

3 class hours.

Credit, 3.

Prerequisites, French 25 and 26, or French 28 and 29.

50. **I. SCIENTIFIC FRENCH.** — For juniors; seniors may elect. This course is planned to meet the requirements of the individual student, and aims to equip him with exact English equivalents for the French scientific terms in his particular science. Word lists of scientific terms will be required, and also weekly readings and reports from scientific works in the subject in which he is majoring. Several scientific readers will be read.

3 class hours.

Credit, 3.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

51. **II. SCIENTIFIC FRENCH.** — For juniors; seniors may elect. As stated under Course 50.

3 class hours.

Credit, 3.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

52. **III. SCIENTIFIC FRENCH.** — For juniors; seniors may elect. As stated under Course 50.

3 class hours.

Credit, 3.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

75. **I. FRENCH LITERATURE.** — For seniors; juniors may elect. The object of Courses 75, 76 and 77 is to give an introduction to recent movements in French literature. Course 75 will deal with the drama, and plays by Augier,

A. Dumas, fils, Delavigne and some contemporary dramatists will be read and studied.

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

76. **II. FRENCH LITERATURE.** — For seniors; juniors may elect. This course deals with the novel. Works by Flaubert, the De Goncourts and Zola will be read. Written reports are required on outside reading.

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

77. **III. FRENCH LITERATURE.** — For seniors; juniors may elect. Modern criticism. Sainte-Beuve, "Causeries du Lundi" (Harper) and works by Taine and Renan. Reference book, Lanson's "Histoire de la Littérature Française."

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

SPANISH.

Elective Courses.

50. **I. ELEMENTARY SPANISH.** — For juniors; seniors may elect. Open to other students upon arrangement. Grammar, with special drill in pronunciation; exercises in conversation and composition. Reading from a reader and selected short stories.

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

51. **II. ELEMENTARY SPANISH.** — For juniors; open to other students upon arrangement. As stated in Course 50.

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

Prerequisite, Spanish 50.

52. **III. ELEMENTARY SPANISH.** — For juniors; open to other students upon arrangement. As stated in Course 50.

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

Prerequisite, Spanish 51.

75. **I. MODERN SPANISH AUTHORS.** — Seniors. Reading from modern Spanish novel and drama. Translation of English into Spanish. Private reading.

3 class hours.

Credit, 3.

Associate Professor MACKIMMIE.

Prerequisite, Spanish 52.

76. **II. MODERN SPANISH AUTHORS.** — Seniors. As stated in Course 75.
3 class hours. Credit, 3.

Associate Professor MACKIMMIE.

Prerequisite, Spanish 75.

77. **III. MODERN SPANISH AUTHORS.** — Seniors. As stated in Course 75.
3 class hours. Credit, 3.

Associate Professor MACKIMMIE.

Prerequisite, Spanish 76.

German and Music.

Associate Professor ASHLEY, Assistant Professor JULIAN.

GERMAN.

The courses in German are intended to give the student a reading knowledge of the language and to introduce to him some of the masterpieces of German literature. To the student interested in pursuing advanced reading in scientific German, opportunity is given to do corollary reading in his major subject, in collaboration with the head of that department.

Required Courses.

1. **I. 2. II. 3. III. ELEMENTARY GERMAN.** — Freshmen; open upon arrangement to other students. Grammar, composition and reading. Especial attention is given to oral work in German and to translation of English into German. Required of those presenting French for entrance who do not continue that language and have not studied German.

3 class hours each term.

Credit, 3 each term.

Associate Professor ASHLEY and Assistant Professor JULIAN.

4. **I. 5. II. 6. III. INTERMEDIATE GERMAN.** — Freshmen; open upon arrangement to other students. Selected works of Schiller, Heine and Goethe. Grammar review and advanced prose composition.

3 class hours each term.

Credit, 3 each term.

Associate Professor ASHLEY.

Prerequisite, required of freshmen who present two years of German for entrance and do not take French.

Elective Courses.

25. **I. INTERMEDIATE GERMAN.** — For sophomores; open upon arrangement to other students. Reading of such works as Sudermann's "Frau Sorge," "Wilhelm Tell," "Die Journalisten," etc. Grammar review.

3 class hours.

Credit, 3.

Assistant Professor JULIAN.

Prerequisites, German 1, 2 and 3.

26. **II. INTERMEDIATE GERMAN.** — For sophomores; open upon arrangement to other students. As stated under Course 25.

3 class hours.

Credit, 3.

Assistant Professor JULIAN.

Prerequisite, German 25.

27. **III. INTERMEDIATE GERMAN.** — For sophomores; open upon arrangement to other students. As stated under Course 25.

3 class hours.

Credit, 3.

Assistant Professor JULIAN.

Prerequisite, German 26.

28. **I. ADVANCED GERMAN.** — For sophomores; open upon arrangement to other students. Reading and studying of Goethe's most important literary productions.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisites, German 4, 5 and 6.

29. **II. ADVANCED GERMAN.** — For sophomores; open upon arrangement to other students. Development of the German novel; rapid reading of great novelists.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisite, German 28.

30. **III. ADVANCED GERMAN.** — For sophomores; open upon arrangement to other students. As stated under Course 29.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisite, German 29.

50. **I. SCIENTIFIC GERMAN.** — For juniors; seniors may elect. Reading in German of modern magazine articles and works of a scientific nature. Different work assigned according to needs of individual students.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

51. **II. SCIENTIFIC GERMAN.** — For juniors; seniors may elect. As stated under Course 50.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisite, German 50.

52. **III. SCIENTIFIC GERMAN.** — For juniors; seniors may elect. As stated under Course 50.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisite, German 51.

75. **I. GERMAN LITERATURE.** — Seniors. Advanced language and literary study. Conducted entirely in German. Lectures on German literature and history; life, customs and travel in Germany. Collateral readings, including masterpieces of different epochs, such as "Nibelungenlied," Goethe's "Faust" and one modern typical drama.

3 class hours.

Credit, 3.

Associate Professor ASHLEY.

Prerequisites, German 28, 29 and 30.

76. **II. GERMAN LITERATURE.** — Seniors. As stated under Course 75.
3 class hours. Credit, 3.

Associate Professor ASHLEY.

Prerequisite, German 75.

77. **III. GERMAN LITERATURE.** — Seniors. As stated under Course 75.
3 class hours. Credit, 3.

Associate Professor ASHLEY.

Prerequisite, German 76.

78. **I. CONVERSATION AND COMPOSITION.** — For seniors; juniors may elect. Translating connected English into German. Reproducing outside readings in German orally in class.

1 class hour.

Credit, 1.

Associate Professor ASHLEY.

Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

79. **II. CONVERSATION AND COMPOSITION.** — For seniors; juniors may elect. As stated under Course 78.

1 class hour.

Credit, 1.

Associate Professor ASHLEY.

Prerequisite, German 78.

80. **III. CONVERSATION AND COMPOSITION.** — For seniors; juniors may elect. As stated under Course 78.

1 class hour.

Credit, 1.

Associate Professor ASHLEY.

Prerequisite, German 79.

MUSIC.

Elective Courses.

50. **I. HISTORY AND INTERPRETATION OF MUSIC.** — For juniors; seniors may elect. History of music among the ancients; medieval and secular music; epoch of vocal counterpoint; development of monophony opera and oratorio; life and works of the greatest representatives of the classical school, — Bach, Händel, Haydn, Gluck and Mozart.

1 class hour.

Credit, 1.

Associate Professor ASHLEY.

51. **II. HISTORY AND INTERPRETATION OF MUSIC.** — For juniors; seniors may elect. A continuation of Course 50. The Romantic school; Beethoven, Schubert, Weber, Mendelssohn, Schumann, Chopin, Berlioz and Liszt; Wagner and the opera.

1 class hour.

Credit, 1.

Associate Professor ASHLEY.

52. **III. HISTORY AND INTERPRETATION OF MUSIC.** — For juniors; seniors may elect. The Modern school and Modern composers.

1 class hour.

Credit, 1.

Associate Professor ASHLEY.

DIVISION OF RURAL SOCIAL SCIENCE.

President BUTTERFIELD.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Agricultural Economics.

Professor CANCE, Mr. SAWTELLE and Assistant Professor —.

Instruction in agricultural economics is designed to show that the agricultural industry justifies its existence chiefly as a supplier of food and raw textile materials for human consumption; that agricultural success is measured by production of values rather than by production of volume of agricultural products; that the goal of the farmer is the largest net profit over a long-time period; that agricultural production includes all processes from purchase of seed and fertilizer and preparation of seedbed until the product reaches the consumer, including collection, transportation, storage, financing, packing, handling and selling; that a knowledge of the business of agriculture and agricultural commerce is to-day more necessary than a knowledge of agricultural technique.

The work of this department is conducted by means of lectures, readings and research in both library and field. A catalogue, now containing some 12,000 cards, covering the various phases of agricultural economics, is maintained. The department is also supplied with a large collection of maps, charts and statistical reports on the prices and supply of agricultural products. A goodly number of regular reports of the Bureau of Markets and other divisions of the United States Department of Agriculture are on file in the office of the department, and available for the use of students. Two series of bound volumes of bulletins are kept in the department offices, with duplicate series in the college library; one series already contains 12 volumes on "Co-operation in Agriculture," and the other, 15 volumes on "Marketing of Farm Products."

Required Course.

26. **II. AGRICULTURAL INDUSTRY AND RESOURCES.** — Sophomores. A descriptive course dealing with agriculture as an industry and its relation to physiography, movement of population, supply of labor, commercial development, transportation, public authority and consumers' demand. The principal agricultural resources of the United States will be studied with reference to commercial importance, geographical distribution, present condition and means of increasing the value of the product and cheapening cost of production. Lectures, assigned readings, class topics and discussions.
5 class hours.

Credit, 5.

Professor CANCE and Assistant Professor —.

Elective Courses.

50. **I. ELEMENTS OF AGRICULTURAL ECONOMICS.** — For juniors; seniors may elect. This course is designed to accompany or follow the course in elements of economics. It deals with the economic principles underlying the welfare

and prosperity of the farmer and those institutions upon which his economic success depends; the economic elements in the production and distribution of agricultural wealth; means of exchange; principles of rural credit; problems of land tenure and land values; taxation of farm property; and the maintenance of the economic status of the farmer. Lectures, text, readings, topics and field work.

5 class hours.

Credit, 5.

Professor CANCE.

51. **III. HISTORICAL AND COMPARATIVE AGRICULTURE.** — For juniors; seniors may elect. A general survey of agriculture, ancient and modern; feudal and early English husbandry; the later development of English agriculture; the course of agriculture in the United States, with special emphasis on the development of agriculture in New England. An attempt will be made to measure the influence of times, peoples and countries in producing different systems of agriculture, and to ascertain the causes now working to effect agricultural changes. Lectures, readings and library work. Students in education and rural journalism should find this course helpful.

5 class hours.

Credit, 5.

Mr. SAWTELLE.

52. **II. CO-OPERATION IN AGRICULTURE.** — For juniors; seniors may elect. The course treats of the history, principles and business relations of agricultural co-operation. (1) A survey of the development, methods and economic results of farmers' organizations and great co-operative movements; (2) the business organization of agriculture abroad, and the present aspects and tendencies in the United States; (3) the principles underlying successful co-operative endeavor among farmers, practical working plans for co-operative associations, with particular reference to credit and purchase and the marketing of perishable products. Lectures, text, assigned readings and practical exercises.

5 class hours.

Credit, 5.

Professor CANCE and Mr. SAWTELLE.

53. **III. THE AGRICULTURAL MARKET.** — For juniors; seniors and graduate students may elect. A study of the forces and conditions which determine the prices of farm products and the mechanism, methods and problems concerned with transporting, storing and distributing them. Supply and demand, course of prices, terminal facilities, the middleman system, speculation in agricultural products, protective legislation, the retail market and direct sales are taken up. The characteristics and possibilities of the New England market are given special attention. Lectures, readings, assigned studies and field work.

5 class hours.

Credit, 5.

Professor CANCE.

76. **II. TRANSPORTATION OF AGRICULTURAL PRODUCTS.** — For seniors and graduate students; juniors may elect. This course deals with the development of highway, waterway and railway transportation and its relation to the agricultural development of the country; the principles governing the operation and control of transportation agencies; present-day problems re-

lating to the shipment of farm products, rates, facilities and services; methods of reducing wastes in transportation; the economics of the good roads movement and of motor transportation. Lectures, text and field work.

5 class hours.

Credit, 5.

Professor CANCE and Mr. SAWTELLE.

77. **I. PROBLEMS IN AGRICULTURAL ECONOMICS.** — For seniors and graduate students; juniors may elect. An advanced course for students desirous of studying more intensively some of the economic problems affecting the farmer. Some of these are: land problems, — land tenure, size of farms, causes affecting land values, private property in land, taxation of farm property; special problems, — cost of producing farm products, farm labor in New England, immigration, agricultural credit. Opportunity will be given, if practicable, for field work, and students will be encouraged to pursue lines of individual interest.

5 class hours.

Credit, 5.

Professor CANCE.

78. **III. AGRICULTURAL CREDIT FACILITIES.** — For seniors and juniors. The legitimate use of credit in the production, storing and marketing of agricultural products. A brief survey of the development of credit institutions, National and State rural credit laws. Farm land banks, credit associations, and other means of securing personal credit. The topics will be discussed from the standpoints of dealers in agricultural produce, the landowning farmer, the tenant and the farm laborer; special attention will be given to the credit needs of the college graduate.

3 class hours.

Credit, 3.

Mr. SAWTELLE.

79. **I. AGRICULTURAL STATISTICS.** — For seniors, juniors and graduate students. This course is designed to deal with the collection, interpretation and presentation of the economic facts of the agricultural industry. The sources of information, methods of obtaining facts, of analyzing and drawing conclusions from economic data, and of presenting agricultural facts convincingly and truly will be treated. Opportunity will be given for laboratory exercises and class discussions on the interpretation of specific data commonly used by county agents, agricultural instructors, specialists and leaders.

1 lecture and 3 2-hour laboratory exercises, credit, 4.

Mr. SAWTELLE.

80. **I. SEMINAR.** — For seniors and graduate students. Research in agricultural economics and history; problems of New England agriculture. Library work and reports. If desirable some other topic may be substituted. Hours to be arranged.

1 2-hour conference period, credit, 1 or 2.

The DEPARTMENT.

81. **II. SEMINAR.** — For seniors and graduate students. As stated in Course 80.

1 2-hour conference period, credit, 1 or 2.

The DEPARTMENT.

82. **III. SEMINAR.** — For seniors and graduate students. As stated in Course 80.

1 2-hour conference period, credit, 1 or 2.
The DEPARTMENT.

Agricultural Education.

Professor HART, Professor WELLES, Assistant Professor BARNES, and Mr. HEALD.¹

The plan of the teacher-training courses is as follows:—

(a) A TWO-YEAR TEACHER-TRAINING COURSE. — Designed for mature persons of approved farm experience and educational advancement, who declare an intention to prepare for teaching in vocational agricultural schools or departments in Massachusetts. This course leads to a certificate of credit from the Massachusetts Department of Education. This certificate places the holder on the preferred list of candidates for teaching in vocational agricultural schools and departments. The course is under the joint guidance of the agent of the Massachusetts Department of Education and the Department of Agricultural Education. Each student's work is so planned that he may pursue with thoroughness the subjects in which his previous preparation may have been deficient. His program is planned with reference to his main objective, whether it is teaching agriculture or an allied subject.

(b) A FOUR-YEAR COLLEGE COURSE. — Entered under the usual entrance conditions. This leads to the degree of bachelor of science and to a teacher's certificate from the Massachusetts Department of Education. This certificate authorizes the holder to teach in a State-aided high school. The program for obtaining a teacher's certificate is planned under the supervision of the Department of Agricultural Education. The course also leads to a certificate of credit from the Massachusetts Department of Education, which places the holder on the preferred list of candidates for teaching in vocational agricultural schools and departments. Students are guided in the choice of courses for the certificate of credit by the Department's agent at the college. The program is carried out in accordance with a co-operative agreement between the Massachusetts Department of Education and the Massachusetts Agricultural College.

(c) PROFESSIONAL IMPROVEMENT COURSE. — Designed for teachers in service who seek improvement. Programs are planned strictly on the basis of individual needs, under the guidance of the agent of the Massachusetts Department of Education at the Massachusetts Agricultural College. In the prosecution of this program a student may enter courses given in the Summer School, in the Winter School, and in the four-year curriculum under the limitations of the schedule and his own qualifications to do the work. When the call seems to justify it, and subject to administrative and equipment limitations, special classes will be organized for carrying out this program. In the case of qualified persons, some of this work may be done in the Graduate School.

(d) COURSES FOR PARTLY PREPARED CANDIDATES. — Designed for supplementing the training of candidates whose qualifications are deficient in one or more particulars for teaching in vocational agricultural schools or departments. These programs may coincide in some cases with those in (a)

¹ Representing the Massachusetts Department of Education in the administration of vocational education acts.

or (c). They are planned under the guidance of the agent of the Massachusetts Department of Education in accordance with a co-operative agreement between the Department and the Massachusetts Agricultural College.

(e) **PRESCRIBED COURSES.**—Some study in the Department of Agricultural Education is required in all the foregoing programs. A minimum of 16 credit hours out of a total of 243 is required in those programs leading to a bachelor of science degree, to a teacher's certificate, or to a certificate of credit.

The equipment includes a combination classroom and laboratory for use in teaching agriculture in secondary schools. It is equipped with filing cases for records; cases for books and apparatus; a display-board for pictures, maps, charts, etc.; individual study desks; tables for supervised study; demonstration table supplied with sink, hot and cold water and gas, etc. The department office is equipped with books and pamphlets on agricultural education, properly catalogued.

Elective Courses.

50. **I. EDUCATIONAL PSYCHOLOGY.**—For juniors; sophomores and seniors may elect. Work planned primarily for candidates for teaching. Consists of a study of the mental growth and development, and some correlations of the mind and nervous system.

5 periods, credit, 5.
Professor HART.

51. **II. PRINCIPLES AND METHODS OF TEACHING.**—For juniors and seniors. A study of the laws of learning, exhaustive inquiry into the meaning of interest, apperception, memory-images, judging and reasoning, and their applications in teaching processes, class management and organization of lesson plans.

5 periods, credit, 5.
Professor HART.

52. **III. HISTORY AND PHILOSOPHY OF EDUCATION.**—For juniors and seniors. A study of educational history in modern times, educational movements in the United States and their bearing on national aims and ideals, with special emphasis on education for a democracy.

5 periods, credit, 5.
Professor HART.

75. **I. ORGANIZATION AND SUPERVISION OF SECONDARY EDUCATION.**—For seniors; juniors may elect. School systems, courses of study, training of teachers, financial support, recent tendencies and policies in secondary schools.

3 periods, credit, 3.
Professor WELLES.

76. **I., II. and III. SPECIAL METHODS IN VOCATIONAL AGRICULTURE.**—For juniors, seniors and others qualified. Consists of the outlining of lessons, outlining of projects for agricultural teaching, and applications of the prin-

ciples of vocational education as embodied in the Smith-Hughes Act, and other legislation relative to agricultural education.

3 periods, credit, 3.
Professor WELLES.

77. **III. COUNTY AGENT WORK.** — For seniors. Work on special agricultural problems by individual students; preparation and presentation of a number of theses, using charts and other apparatus. Major advisers will be responsible for accuracy of subject-matter; the Department of Agricultural Education will be responsible for preparation and presentation.

5 periods, credit, 5.
Assistant Professor BARNES.

80. **I., II., III. and IV. TEACHER-TRAINING COURSE.** — For seniors and graduate students. Work will consist of supervised apprentice teaching accompanied by the arranging of subject-matter for lessons, the outlining of projects, and professional study. The number of credits will depend upon the number, character and length of teaching exercises and conferences. The work will be carried on in co-operation with the Massachusetts Department of Education.

Credits, 1 to 5.
Professor WELLES.

Rural Sociology.

Professor PHELAN, President BUTTERFIELD, Professor HART, Mr. —.

The courses in rural sociology are designed for two purposes: first, to give students an appreciation of the general problems of country life; second, to afford a definite training for students who wish to take up some specific form of social service. In the last ten years rural sociology has been introduced as a subject into more than 50 per cent of the agricultural schools and colleges. There is a good demand for teachers, and an increasing opportunity in other directions in this subject. The courses afford the student an opportunity to pursue graduate as well as undergraduate work. The library of the college is unusually well equipped with rural sociological material.

Required Course.

27. **III. ELEMENTS OF RURAL SOCIOLOGY.** — Sophomores. A broad survey of the field of rural sociology, including such topics as the origin of rural sociology, its methods and problems; relation of sociological to the scientific and technical aspects of agricultural problems; the development of the rural community in New England and the west, religious, educational and social ideals of rural people; characteristics and influence of the rural environment, the movement of the rural population, the effects of immigration; rural institutions, the school, the church, local government, effects of modern conditions of life on rural institutions; rural organization; problems of progress, an analysis of the needs of rural life in its further development. Lectures, readings and essays on assigned topics.

3 class hours.

Credit, 3.
Professor PHELAN and Mr. —.

Elective Courses.

50. **I. SOCIAL CONDITION OF RURAL PEOPLE.** — For juniors; seniors may elect. A. The rural status: composition of the rural population, nature, extent and causes of diseases and accidents, health agencies of control; extent and causes of rural delinquency and dependency, conditions of temperance, of sexual morality and family integrity; child labor, women's work and position; standard of living, size of family; cultural ideals; community consciousness and activity; standards of business conduct and of political ethics.

B. Rural social psychology: characteristics of the rural mind, character of hereditary and environmental influence; nature and effect of face-to-face groups; fashion, conventionality, custom, character of discussion and of public opinion.

3 class hours.

Credit, 3.

Professor PHELAN.

51. **II. RURAL GOVERNMENT.** — For juniors; seniors may elect. A general survey of the development of rural government in the United States, origin of the New England town, its influence upon the west, advantages, development of efficiency, county government, the influence of the farmer in legislation, good roads movement, credit facilities, taxation, boards of agriculture, agricultural colleges and experiment stations in relation to rural welfare; national government; a general survey of political organizations and movements among farmers in the United States and foreign countries and their influence in shaping legislation; relation of the Department of Agriculture, postal system, the various national commissions and agencies to rural welfare. Lectures, readings, written exercises on assigned topics.

3 class hours.

Credit, 3.

Professor PHELAN and Mr. —.

52. **III. RURAL ORGANIZATION.** — For juniors; seniors may elect. A study of the organized agencies by which rural communities carry on their various forms of associated life, particularly a study of the ways by which the domestic, economic, cultural, religious and political institutions contribute to rural betterment; principles underlying leadership, qualifications of the paid leader and the lay leader; the field of rural social service, national, State and local, preparation and opportunity for service; rural community building, a study of organized ways and means by which aid is given local communities.

3 class hours.

Credit, 3.

President BUTTERFIELD.

75. **I. FARMERS' ORGANIZATIONS.** — For seniors; juniors may elect. The history, purposes and achievements of the grange, the Farmers' Union, farmers' clubs, village improvement associations, boys' clubs, etc.; the method, scope and history of local, State and national associations formed about some farm product, their influence in forming class consciousness and in shaping agrarian legislation; need of federation. Lectures, readings and essays on assigned topics.

3 class hours.

Credit, 3.

Professor PHELAN.

76. **I. FIELD WORK IN RURAL SOCIOLOGY.** — For seniors; juniors may elect. This course is designed to meet the needs of students who wish to do some constructive work in rural social service while still in college. The work will be carried on in co-operation with the various college agencies engaged in rural service. Any project for which credit in this course is to be asked must first have the approval of the head of the department.

From 2 to 6 laboratory hours, credits, 1 to 3.

Professor PHELAN.

Prerequisites, Rural Sociology 27 and 52.

77. **II. RURAL SOCIAL SURVEYS.** — For seniors; juniors may elect. A careful study of the theory and function of statistics, the limitations and difficulties in the use of statistics, the interpretation of statistical data, various methods of graphic representation; a study of surveys, kinds and use, method of gaining information, the basis for conclusions, value of information gained. Text and lectures.

3 class hours.

Credit, 3.

Professor PHELAN.

78. **II. RURAL AND BUSINESS LAW.** — For seniors; juniors may elect. The work of this course will cover such points as land, titles, public roads, rights incident to ownership of live stock, contracts, commercial paper and distinctions between personal and real property. Text, written exercises, lectures and class discussions.

5 class hours.

Credit, 5.

Professor HART.

79. **I. SEMINAR.** — Credits, 1 to 3.

Professor PHELAN.

80. **II. SEMINAR.** — Credits, 1 to 3.

Professor PHELAN.

81. **III. SEMINAR.** — Credits, 1 to 3.

Professor PHELAN.

Rural Home Life.

Miss SKINNER.

The Department of Rural Home Life offers elective courses for students majoring in other departments of the college. Fundamentally this training is such as will help young women to be better prepared to adjust themselves readily to their environment in the home and in the community, and to help them realize their responsibility as good homemakers and as good citizens. In addition to the elective courses indicated, courses in foods, clothing, business of the household and home care of the sick are offered to students in the two-year course in practical agriculture, and to students in the Ten Weeks' Winter School; and courses for teachers are offered in connection with the work of the Summer School.

The food laboratory, located in the entomology building, is fitted with individual desks (cabinet form) to hold utensils and materials for each student. Each table is equipped with gas stoves. A storage cabinet is provided with bins for supplies and cupboard space for large utensils and illustrative material. This room is well lighted and pleasant. The clothing laboratory is

attractively located in French Hall. The equipment consists of sewing machines, cabinets, work tables, cutting tables, electric irons, dress forms and a collection of materials illustrating the production of textiles for clothing and household use.

Elective Courses.

25. **I.** 26. **II.** 27. **III.** **TEXTILES AND CLOTHING.**—Sophomores. The selection and purchase of suitable materials, their character, cost and durability. Appropriateness and simplicity in dress. There will be practical work in hand and machine sewing, drafting and designing of patterns, the care and repair of clothing.

1 lecture.

2 2-hour laboratory periods, credit, 3.

50. **I.** 51. **II.** 52. **III.** **FOODS AND COOKERY.**—Juniors. A course to establish a fundamental knowledge of foods. The lectures deal with a discussion of the comparative composition, cost and economic value of food-stuffs; their sources, production and manufacture. Laboratory practice in applying scientific principles to the selection and preparation of typical foods.

1 class hour.

2 2-hour laboratory periods, credit, 3.

Miss SKINNER.

75. **I.** 76. **II.** **HOUSEHOLD MANAGEMENT.**—Seniors. This course deals with the application of the principles of scientific management to the household, and the elements of successful home making. It includes a study of the family income, cost of living, household accounts, the budget and its apportionment. Consideration will also be given to the responsibility of the woman to her family and the community in establishing right standard of living.

2 class hours.

Credit, 2.

Miss SKINNER.

78. **III.** **HOME NURSING.**—Seniors. This course includes a study of the care of the family health; simple diseases and their prevention; the care of young children and invalids; first aid to the injured.

2 class hours.

Credit, 2.

Miss SKINNER.

GENERAL DEPARTMENTS.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Military Science and Tactics.

Lieut.-Col. R. W. WALKER, U. S. A.; Ordnance Sergeant JOHN J. LEE, U. S. A., retired.

Under act of Congress (July 2, 1862) military instruction under a regular army officer was required in this college of all able-bodied male students. Under act of Congress June 3, 1916, as amended by act of Congress Sept. 8, 1916, there was established at this college in April, 1917, an infantry unit of the Reserve Officers Training Corps. Following the World War and an act of Congress (July 9, 1918) the Reserve Officers Training Corps is in operation under the regulations of the War Department, administered by the president of the college and the professor of military science and tactics.

The primary object of the R. O. T. C. is to provide systematic military training at civil educational institutions, for the purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time the students are pursuing their general or professional studies, with the least practical interference with their civil careers by employing methods designed to fit men physically, mentally and morally for pursuits of peace as well as war.

All candidates for a degree in a four-year course must take for two years three hours a week of military training.

Students in their junior and senior years, who are approved by the president and the professor of military science and tactics, may take the advanced course, if they so elect. The advanced course consists of five hours per week and a summer camp of about six weeks during the summer vacation, between the junior and senior years. Students taking this course are paid by the Federal government at a rate to be fixed by the Secretary of War, not to exceed the value of the army ration. The rate now fixed is 40 cents per day, which amounts to about \$140 per year. Students graduating in the advanced course are eligible for commissions in the Reserve Officers Corps, *but are not required to accept such commission if offered.*

The required uniform is of olive drab woolen cloth, and is furnished for the use of the students by the Federal government without cost. It is worn by all cadets when on military duty, and may be worn at other times. New uniforms are furnished each year.

The establishment in the near future of a cavalry unit of the R. O. T. C. is contemplated. This work should fit in well with the Departments of Animal Husbandry and Veterinary Science, besides affording students a recreational and physical exercise not usually found at educational institutions.

Required Courses.

1. **I. TACTICS.** — Freshmen. Theoretical instruction through the school of the soldier and squad. Lectures on military subjects.

1 class hour.

Credit, 1.

Lieutenant-Colonel WALKER.

2. **II. TACTICS.** — Freshmen. Theory of small-arms firing, minor tactics, guard duty, personal hygiene and first-aid.

1 class hour.

Credit, 1.

Lieutenant-Colonel WALKER.

3. **III. TACTICS.** — Freshmen. Theoretical instruction in Infantry Drill Regulations. Lectures on military subjects.

1 class hour.

Credit, 1.

Lieutenant-Colonel WALKER.

4. **I. DRILL.** — Freshmen. Practical instruction in Infantry Drill Regulations, schools of the soldier, squad and company, close and extended order.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

5. **II. DRILL.** — Freshmen. Physical drill, position and aiming drills, gallery practice.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

6. **III. DRILL.** — Freshmen. Practical instruction in infantry drill, marching, ceremonies, guard.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

25. **I. TACTICS.** — Sophomores. Infantry Drill Regulations, elementary topography and map reading. Lectures on military subjects.

1 class hour.

Credit, 1.

Lieutenant-Colonel WALKER.

26. **II. TACTICS.** — Sophomores. Theory of small-arms firing and musketry, minor tactics, signalling.

1 class hour.

Credit, 1.

Lieutenant-Colonel WALKER.

27. **III. TACTICS.** — Sophomores. Theoretical instruction in Infantry Drill Regulations, field engineering. Lectures on military subjects.

1 class hour.

Credit, 1.

Lieutenant-Colonel WALKER.

28. **I. DRILL.** — Sophomores. Practical instruction in Infantry Drill Regulations, schools of the soldier, squad and company, close and extended order, bayonet, hand grenade (dummy).

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

29. **II. DRILL.** — Sophomores. Physical drill, position and aiming drills, gallery practice.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

30. **III. DRILL.** — Sophomores. Practical instruction in infantry drill, marching ceremonies, guard, range practice.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

Elective Courses.

50. **I. MILITARY SCIENCE.** — Juniors. Topography, minor tactics, lectures, Infantry Drill Regulations.

3 class hours.

Credit, 3.

Lieutenant-Colonel WALKER.

51. **II. MILITARY SCIENCE.** — Juniors. Law, common and military, minor tactics. Lectures on military subjects.

3 class hours.

Credit, 3.

Lieutenant-Colonel WALKER.

52. **III. MILITARY SCIENCE.** — Juniors. Minor tactics, field engineering.

3 class hours.

Credit, 3.

Lieutenant-Colonel WALKER.

53. **I. DRILL.** — Juniors. Duties consistent with rank as cadet officers or noncommissioned officers in connection with practical work laid down for the unit.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

54. **II. DRILL.** — Juniors. As stated under Course 53.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

55. **III. DRILL.** — Juniors. As stated under Course 53.

2 laboratory hours.

Credit, 1.

Lieutenant-Colonel WALKER and Sergeant LEE.

75. **I. MILITARY SCIENCE.** — Seniors. Advanced topography and the solution of map problems. Minor tactics, company administration, hipology, Infantry Drill Regulations.

3 class hours.

Credit, 3.

Lieutenant-Colonel WALKER.

76. **II. MILITARY SCIENCE.** — Seniors. Military law, military policy of the United States, minor tactics. Lectures on military subjects.

3 class hours.

Credit, 3.

Lieutenant-Colonel WALKER.

77. **III. MILITARY SCIENCE.** — Seniors. Tactical walks, military history of the United States, field engineering.

3 class hours.

Credit, 3.

Lieutenant-Colonel WALKER.

78. **I. DRILL.** — Seniors. As stated under Course 53.
 2 laboratory hours. Credit, 1.
 Lieutenant-Colonel WALKER and Sergeant LEE.

79. **II. DRILL.** — Seniors. As stated under Course 53.
 2 laboratory hours. Credit, 1.
 Lieutenant-Colonel WALKER and Sergeant LEE.

80. **III. DRILL.** — Seniors. As stated under Course 53.
 2 laboratory hours. Credit, 1.
 Lieutenant-Colonel WALKER and Sergeant LEE.

Physical Education and Hygiene.

Professor HICKS, Assistant Professor GORE, Mrs. HICKS, Mr. GRAYSON, Mr. MCCARTHY,
 Mr. DERBY.

The purpose of the courses offered by this department is to provide active exercise and to instruct every student how to care for his health and maintain his physical condition while carrying on his college course.

The equipment consists of the Alumni Athletic Field, which has room for two football fields, a quarter-mile cinder track with a 220 straightaway, and the baseball diamond; and also the old field for class football and baseball, two tennis courts, and the drill hall floor for basket-ball. For several years the drill hall floor was used for class work in gymnastics, but its condition has become so bad that this has been discontinued. During the winter months a hockey rink is provided on the college pond.

[All classified undergraduate male students are given a physical examination upon entering.]

MEN.

Required Courses.

1. **I. HYGIENE.** — Freshmen. Lectures on personal hygiene.
 1 class hour. Credit, 1.
 Professor HICKS.
2. **I. RECREATION.** — Freshmen. Outdoor games.
 1 laboratory hour. Credit, third term.
 Mr. DERBY.
3. **III. RECREATION.** — Freshmen. Outdoor games.
 1 laboratory hour. Credit for Nos. 2 and 3, 1.
 Mr. DERBY.
25. **I. RECREATION.** — Sophomores. Outdoor games.
 1 laboratory hour. Credit, third term.
 Mr. DERBY.
26. **III. RECREATION.** — Sophomores. Outdoor games.
 1 laboratory hour. Credit for Nos. 25 and 26, 1
 Mr. DERBY.

Elective Course.

77. **III. TRAINING COURSE.** — Seniors. Election by permission only.
History of physical education and supervision of athletics.

1 class hour.

Credit, 1.

Professor HICKS.

WOMEN.*Required Courses.*

4. **I. RECREATION.** — Freshmen. Outdoor games.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

5. **II. GYMNASTICS.** — Freshmen. Dancing, Swedish games, etc.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

6. **III. RECREATION.** — Freshmen. Outdoor games.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

27. **I. RECREATION.** — Sophomores. Outdoor games.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

28. **II. GYMNASTICS.** — Sophomores. Dancing, Swedish games, etc.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

29. **III. RECREATION.** — Sophomores. Outdoor games.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

Elective Courses.

50. **II. GYMNASTICS.** — Juniors. Dancing, Swedish games, etc.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

76. **II. GYMNASTICS.** — Seniors. Dancing, Swedish games, etc.

3 laboratory hours.

Credit, 1.

Mrs. HICKS.

THE LIBRARY.

The library — stack room, reading room and office — occupies the entire lower floor of the Chapel-library building. It contains about 63,000 volumes and a large number of bulletins, farm papers and other material, which is being put into good working order as fast as possible. Works on agriculture, horticulture, botany, entomology and the various sciences predominate, but literature, history and sociology are well represented and receive due attention. The reading room provides a good variety of popular and technical periodical literature, encyclopedias and general reference books.

The library is being reclassified and recatalogued in order to make the splendid material accessible and of the greatest working value. Every effort is being made toward developing the college library into a vital intellectual center, of equal value to every student, teacher and teaching department on the college campus. Consequently only the most cordial relations are cherished, and the fewest and most imperative rules concerning the circulation of books and department are enforced. An agricultural reference library is maintained in Stockbridge Hall, and department libraries are also maintained in some of the other buildings on the campus.

Occasional lectures are given to regular and short-course students in order to make the best use of the library equipment. Emphasis is laid upon the card catalogue, periodical indexes, bibliographies and guides, and the large collections of United States Department of Agriculture and experiment station literature.

Library hours are from 8 A.M. to 9.30 P.M. every week day, and from 9 A.M. to 1.30 P.M. on Sundays in term time. Shorter hours prevail during vacation.

THE GRADUATE SCHOOL

THE GRADUATE SCHOOL.

KENYON L. BUTTERFIELD, A.M., LL.D., President of the College.

CHARLES H. FERNALD, Ph.D., Honorary Director of the Graduate School.

CHARLES E. MARSHALL, Ph.D., Director of the Graduate School and Professor of Microbiology.

GRADUATE STAFF, 1918-19.

Professor BEAUMONT, Professor CANCE, Professor CHAMBERLAIN, Assistant Professor O. L. CLARK, Professor CRAMPTON, Professor FERNALD, Professor FOORD, Professor GRAHAM, Associate Professor ITANO, Professor LINDSEY, Professor McNUTT, Professor OSMUN, Professor PETERS, Professor PHELAN, Professor SEARS, Professor WAUGH, Director MARSHALL, President BUTTERFIELD; Mr. WATTS, Secretary.

Graduate courses leading to the degrees of master of science and doctor of philosophy have been given for a number of years; the degrees of master of agriculture and doctor of agriculture are now granted to meet strictly professional needs. The number of requests for each of these courses is apparently increasing. In recognition of the benefits to be derived from a separate organization, a distinct graduate school has been established for the purpose of fitting graduates of this and other institutions for teaching in colleges, high schools and other public schools; for positions as government, State and experiment-station specialists in farm management, dairying, live-stock husbandry, poultry science, agronomy, landscape gardening, pomology, vegetable gardening and floriculture; for positions as bacteriologists, botanists, chemists, entomologists; and for numerous other positions requiring a great amount of scientific and professional knowledge, training and experience.

ORGANIZATION.

The school is based upon the department as the unit, and the apprenticeship system as the most effective means of instruction. This gives to the student individuality in treatment and an intimacy with actual conditions of work and operations. Besides, each student is assigned to an advisory committee, composed of the instructor in charge of his major subject as chairman, and instructors in charge of his minor subjects as members, which directs his graduate studies. The chairmen of all these committees together constitute the graduate staff, which controls the policy of the graduate school.

ADMISSION.

Admission to the graduate school will be granted:—

1. To graduates of the Massachusetts Agricultural College.
2. To graduates of other institutions of good standing who have received a bachelor's degree substantially equivalent to that conferred by this college.

In case an applicant presents his diploma from an institution of good standing, but has not, as an undergraduate, taken as much of the subject he selects

for his major as is required of undergraduates at the Massachusetts Agricultural College, he will be required to make up such parts of the undergraduate work in that subject as the instructor in charge may consider necessary. He shall do this without credit toward his advanced degree.

Admission to the graduate school does not necessarily admit to candidacy for an advanced degree, — students holding a bachelor's degree being in some cases permitted to take graduate work without becoming candidates for higher degrees.

Applications for membership in the graduate school should be presented to the director of the school. Full statements of the applicant's previous training, of the graduate work desired, and of the amount and kind of work already done by him as an undergraduate should be submitted, together with a statement whether the applicant desires to work for a degree.

Registration is required of all students taking graduate courses, the first registration being permitted only after the student has received an authorization card from the director.

NATURE, METHODS AND REQUIREMENTS OF GRADUATE WORK.

Graduate work differs from undergraduate work in its purposes and methods. The primary aims of the instructor are emphasized in an attempt to have the student adjust himself and place himself in his environment; develop the rule of self-direction and self-instruction; acquire the power of accurate reasoning; gain proficiency and skill in his selected field of study or practice; and obtain an appreciative and discriminative insight into experimentation and original research. Methods are not devised, therefore, for attractiveness, entertainment and superficial reviews, but for the creation of initiative and profound thought, thorough acquaintance with detail, independent advance and industrious habits. Careful readings, lectures, conferences, surveys, laboratory exercises and field work are some of the agencies utilized.

All members of the graduate school are required to attend the course of lectures designed to supplement the technical work of all graduate studies. These lectures will be given once each week, and the students will be held responsible for the work. [Suspended during continuance of the war.]

Candidates for the degree of master of science are required to prosecute two subjects, one of which shall be designated as a major and the other as a minor. These subjects may not be selected in the same department. An original thesis is considered a part of the major subject.

Candidates for the degree of doctor of philosophy are required to prosecute three subjects, one of which shall be designated as the major and the others as minors. No two of these subjects may be taken in the same department. An original thesis shall be considered a part of the major subject.

Candidates for the degree of master of agriculture are allowed greater privileges in the selection of subjects, but will be required to select a major and such other supporting lines of study as will be necessary properly to equip the individual professionally.

Candidates for the degree of doctor of agriculture are required to select a major and such other subjects as will develop the major in its greatest intensity and comprehensiveness. Successful experience is also requisite, together with a thesis which represents a masterly survey or intimate study through accurate application of some phase of the major subject.

Candidates for the degree of master of landscape architecture will be expected to conform to the established courses of the department, and to the requirements of the department in the preparation of a thesis, as well as in actual experience outside the college.

Candidates for membership in the graduate school who do not desire to work for a degree may, with the approval of the director of the school, take more than one subject in the same department, or pursue work in several departments, if their preparation will permit. A statement of the subjects chosen must in each case be submitted to the director of the graduate school for approval by the student's advisory committee. The chosen subjects must bear an appropriate relation to each other.

A working knowledge of French and German is essential to successful graduate work, and students not having this will find it necessary to acquire it as soon as possible after entering.

The graduate staff reserves the privilege of recommending and allowing courses in other institutions as a part of residence instruction. Such supervision will be exercised and credit granted as are essential to the highest standards of efficiency.

THESES.

A thesis is required of each candidate for an advanced degree. It must be on a topic belonging to the candidate's major subject; must show that its writer possesses the ability to carry on original study; and must be an actual contribution to knowledge.

The thesis in its final form, must be submitted to the director by May 15 of the year in which the student is to present himself for the advanced degree, and before he may take the required examination. Three complete copies are required. One of the said copies is to be retained as an official copy by the said director, one is to be deposited in the college library, and the third is to be retained by the department in which the thesis was prepared. The candidate for the doctor's degree must be prepared to defend at the oral examination the views presented in his thesis.

FINAL EXAMINATIONS.

For the degree of master of science, master of agriculture, or master of landscape architecture, final examination, which may be either written or oral, or both, is given upon the completion of each subject.

For the degrees of doctor of philosophy and doctor of agriculture, final examinations on the minors taken are given upon the completion of the subjects. In the major subject, a written examination, if successfully passed, is followed by an oral examination in the presence of the faculty of the school.

DEGREES CONFERRED.

The degrees of master of science, master of agriculture and master of landscape architecture are conferred upon graduate students who have met the following requirements: —

1. The devotion of at least one year and a half¹ to the prosecution of study in two subjects of study and research, not less than one full college year of which must be in residence. In the case of a master of landscape architecture the student must follow the prescribed course of study.

¹ All time statements refer to minimum time.

2. The earning of not less than fifty credits in the chief or major subject, and of not less than twenty-five credits in the minor subject. Students pursuing the course in landscape architecture will devote all of their time to the established course, and meet the conditions of one year of experience outside the college.

3. The preparation of a thesis in the major subject, constituting an actual contribution to knowledge, and accompanied by drawings if necessary. The thesis may be waived for the degree of master of agriculture.

4. The passing of final examinations, in both major and minor subjects, to the satisfaction of the professors in charge.

5. The payment of all fees and college expenses required.

The degrees of doctor of philosophy and doctor of agriculture are conferred upon graduate students who have met the following requirements:—

1. The devotion of at least three years to the prosecution of three subjects of study and research in residence at the college.

2. The earning of not less than one hundred credits in the chief or major subject, and of not less than twenty-five credits in each of two minor subjects.

3. The preparation of a thesis, in the major subject, constituting an actual contribution to knowledge and accompanied by drawings if necessary. For the degree of doctor of agriculture the thesis may be modified to meet professional requirements.

4. The passing of final examinations, in both the major and minor subjects, to the satisfaction of the instructors in charge.

5. The payment of all fees and college expenses required.

The fee for the degree of master of science, master of agriculture, or master of landscape architecture is \$10, and for the degree of doctor of philosophy or doctor of agriculture, \$25.

COURSES OFFERED.

Courses available as major subjects for the degree of doctor of philosophy:—

Agricultural economics.
Botany.
Chemistry.
Entomology.

Horticulture.
Microbiology.
Rural sociology.

Courses available as major subjects for the degree of master of science:—

Agricultural economics.
Agricultural education.
Agriculture.
Agronomy.
Animal husbandry.
Botany.
Chemistry.

Entomology.
Horticulture.
Mathematics and physics.
Microbiology.
Poultry science.
Rural sociology.
Veterinary science.

Courses available as major subjects for the degree of master of agriculture:—

Agronomy.

Animal husbandry.

Poultry science.

The course in landscape architecture leads to the degree of master of landscape architecture.

Courses available as minor subjects for the degree of doctor of philosophy: —

Agricultural economics.
Agricultural education.
Agriculture.
Agronomy.
Animal husbandry.
Animal pathology.
Botany.
Chemistry.

Entomology.
Horticulture.
Landscape architecture.
Mathematics and physics.
Microbiology.
Poultry science.
Rural sociology.
Zoölogy.

Courses available as minor subjects for the degree of master of science: —

Agricultural economics.
Agricultural education.
Agriculture.
Agronomy.
Animal husbandry.
Animal pathology.
Botany.
Chemistry.
Entomology.

Horticulture.
Landscape architecture.
Mathematics and physics.
Microbiology.
Poultry science.
Rural sociology.
Veterinary science.
Zoölogy.

GENERAL OUTLINE OF COURSES FOR ADVANCED DEGREES.

Agricultural Economics (Major Course). — 1. Graduate research work in agricultural economics will be developed by four principal methods, namely, historical, statistical, accounting and general field investigation. In all instances the method includes facility in investigation, tabulation and interpretation of results.

2. Candidates for the doctorate, the master's degree, or candidates offering a minor in agricultural economics, will be required to pass an examination covering the undergraduate work now offered in agricultural economics, including Course 50, the elements of economics, Course 75, the agricultural market and Course 52, co-operation in agriculture; and in addition such definite research work as may be outlined by the department, to consist of original investigations in some particular divisions of the subject of agricultural economics. Courses 52, 53, 76, 77, 78 and 79 are for graduates and undergraduates. Special investigations may be made by electing seminars 80-82 in agricultural economics.

3. Candidates for the doctor's degree will be required to write a thesis, and candidates for the master's degree a thesis or a report, covering results of a specific line of personal investigation in one or more fields of the subject. Each candidate will also be required to have a working knowledge of the general field of economics, the theory of agricultural economics, the problems of agricultural production, land tenure, land problems, agricultural commerce, agricultural co-operation, agricultural credit, statistics of agriculture and prices, and markets and marketing.

Agricultural Education. — Work offered in this department may be taken as a major or minor for the degree of master of science or as a minor for the degree of doctor of philosophy or master of science. Three lines of study are open to students who are properly qualified, — agricultural education, public school supervision, and the philosophy of education. In order to enter upon any one of these for credit towards an advanced degree the candidate must present evidence of proficiency in at least five courses in

agricultural education as outlined for undergraduates, or their equivalent. Open to persons holding a bachelor of science degree from this college or its equivalent; also to school superintendents, principals and to teachers of successful experience and of mature years who wish to avail themselves of this opportunity for advanced study even though not candidates for a degree.

Agronomy (Master of Science). — Graduate students desirous of taking major work in agronomy should have had a good training in the fundamentals of the natural sciences, since agronomical problems involve the application of the natural sciences especially. They should have taken Agronomy 27 and 50, or their equivalents, and other courses given by this department along the line of the problem on which they will work, and should have a command of the laboratory technique required for their problems. Problems may be chosen in which particular attention is devoted to soils, fertilizers or field crops. The specific problem is selected in conference with the major adviser, consideration being given to the student's desires and abilities.

Although this department does not attempt to limit the field of research in agronomy, the following phases are suggested to the prospective graduate student: —

I. SOILS AND FERTILIZERS. — (a) Soil physics: Textural relationships of soil classes; adsorption phenomena; physical properties in relation to mineralogical and chemical properties; soil structure; moisture relationships; the colloidal conditions of soils, etc.

(b) Soil chemistry: Nitrogen fertilization, including commercial supply and gain or loss under different systems of soil management; absorption of potash and phosphoric acid; sulfur fertilization; soil acidity, etc.

(c) Soil biology: Fixation of nitrogen by symbiotic and nonsymbiotic organisms; changes of green and animal manures in the soil, — ammonification and nitrification; care and preservation of manures; humus in relation to soil fertility, etc.

II. FIELD CROPS. — (a) Varieties: Classification; adaptation to climatic and soil conditions, etc.

(b) Distribution as affected by natural and economic conditions.

(c) Cultural methods: Early and late planting of the potato seed crop, of silage corn; spacing of plants; keeping qualities as affected by time and methods of harvesting; tillage and moisture control, etc.

(d) Storage of cereals, roots and tubers as affected by aeration, temperature, humidity, previous treatment, etc.

(e) Crop improvement, involving the application of the principles of plant-breeding to special crops.

After the selection of a topic for investigation the student is required to formulate the problem in detail, develop a line of attack, carry on the work and present the results in a thesis acceptable to the staff of the Graduate School. The student is required to familiarize himself with the literature bearing on the subject.

A graduate student taking a minor in this department will be required first to take certain of the regular courses offered by the department, unless he has already had them or their equivalents. The work assigned will then depend somewhat on the time required to complete these courses.

It is the aim of the department to supply laboratory, greenhouse and field facilities for attacking agronomical problems through most of the known means. These facilities are intended primarily for the use of graduate stu-

dents doing major work in agronomy, but others will be allowed to use them when circumstances permit.

Animal Husbandry (Master of Science). — **COURSE A. ANIMAL BREEDING.** — 1. Reading: Thorough survey of the scientific works dealing with plant and animal breeding and improvement.

2. Project: Each student must outline and pursue some Mendelian problem.

3. Thesis: This is to be a complete treatise of the problem which the student undertakes; it should be a valuable contribution to the present knowledge of the question of animal breeding.

COURSE B. ANIMAL NUTRITION. — This course is in outline similar to A. It is designed to cover the field of nutrition, feeding and management of live stock.

Seminar: Regular periods will be devoted to a discussion of the projects undertaken, together with criticisms of the available material on the question pursued.

Object. — To give the student a comprehensive knowledge of feeding, breeding and management of live stock. This may be divided into a major and a minor, in order to give the student the opportunity of devoting a proportionate share of his time to the class of live stock in which he is particularly interested.

Reading. — The student is to make a very complete survey of experimental and periodical literature dealing with the various phases of the subject.

Practice. — Before the completion of the work for the degree, the student must have the equivalent of at least one year's continuous work on an approved live-stock farm.

Seminar: Regular periods to discuss progress of the work.

Animal Pathology (Minor Course only). — 1. Reviews in anatomy.

2. Reviews in organography and histology.

3. Special lectures and readings in general and special pathology.

4. Laboratory studies in general and special pathology.

5. Pathological technique.

6. Conferences.

Botany (Major Courses). — The equivalent of certain undergraduate courses, determined in the case of each student by the department, is prerequisite. Candidates for the degree of master of science are required to pass a final examination in writing. A final examination in writing before the department and an oral examination before the graduate staff must be passed by candidates for the degree of doctor of philosophy. Candidates for the latter degree are required to attend all graduate lectures given by the department. Candidates for the degree of master of science will take those lectures given during their period of study in the department. All lecture courses will be given in rotation, except Courses 1 and 2, which will come every year. There will be three lectures a week throughout the fall, winter and spring terms. These lecture courses, outlined below, are designed to cover a period of three years.

1. **PLANT PHYSIOLOGY.** — The lectures will consider, under the nutrition of the plant: its chemical structure, absorption of various nutrient substances and their changes in the plant, assimilation and dissimilation of carbon and nitrogen by autotrophic and heterotrophic plants; under changes in the form of plants: growth and form under constant external factors, the influence of variable external and inner factors on growth, form and development; and under plant movements: the various tropisms, nutations, etc. Supplemental

demonstrations, laboratory work and readings in the standard texts and journals. One lecture a week for 36 weeks.

2. **PLANT PATHOLOGY.** — A general consideration of the history, nature and causes of plant disease; parasitism, predisposition, immunity, degeneration, natural and artificial infection, dissemination, epidemics, biologic strains, monstrosities and malformations, proliferation, prevention and control, economics of plant diseases. One lecture a week for 36 weeks.

3. **NORMAL AND PATHOGENIC METABOLISM.** — The lectures in this subject embrace, in more or less detail, comparative consideration of the metabolism of the host in health and disease; the metabolism of the parasite under varying conditions; enzyme activities in host and parasite; methods of preparation and determination of enzyme activities; chemical and physical changes induced in plant tissue by parasites; immunity, etc. Current investigations and new phases of the subjects under discussion will also receive attention as they appear. One hour a week for 24 weeks.

4. **THE COMPARATIVE ANATOMY OF GREEN PLANTS.** — In these lectures an intensive study is directed to the comparative anatomy of green plants from the evolutionary standpoint. Particular emphasis is laid upon the woody forms both living and extinct. Of the latter the department is fortunate in possessing excellent sets of micro-preparations and lantern slides.

5. **BIOLOGIC RELATIONS.** — Consideration of certain phases of the morphological and physiological adaptations of plants with regard to insect visit; the rôle of thorns, hairs, tendrils, glands, etc. Various experiments will be made to test out experimentally some of the existing theories concerning biologic adaptations. One lecture a week for 12 weeks.

6. **THE ECOLOGY OF PLANTS.** — This course deals with the water, light and temperature relations of plants, and the various adaptations in response to these factors; the various types of plant formation; the migration of plants; the competition of plants; invasion and successions of plants under varied conditions; and the various types of alternations and zonations. One lecture a week for 12 weeks.

7. **PHYSIOLOGICAL PLANT PATHOLOGY.** — This course considers those plant diseases not due to bacterial or fungous parasites, but resulting from unfavorable physical or chemical conditions of the soil; from harmful atmospheric influences, such as too dry air, too much moisture, hail, wind, lightning, frost; from injurious gases and liquids; from lack of or too much light; from wounds. A knowledge of the normal physiology of the plant is required. Demonstrations and laboratory work will be given, together with assigned readings. One lecture a week for 12 weeks.

8. **HISTORY OF BOTANY.** — A historical survey of the science; lives of noted botanists; history of certain culture plants, such as wheat, corn, coffee, potato, rice, and their influence on civilization; reading. One lecture a week for 18 weeks.

Seminar: A weekly seminar for members of the department staff, graduate students and major senior students is held, at which important current botanical papers are discussed. Attendance and participation are required.

Collateral Reading: Extensive reading of botanical literature in English, German and French, designed to give the student a broad knowledge of the science, is required of all major students. Final examinations are based in part upon this reading course.

Thesis: Each major student is required to select a problem in plant pa-

thology or physiology (in other branches at the discretion of the department) for original investigation, and the thesis must embody a distinct contribution to knowledge. An effort will be made to assign problems having some bearing on scientific and economic agriculture.

Minor Course. — For a minor a student may take such of the work offered by the department as seems best suited to his major course. In most cases no problem will be assigned.

Professor OSMUN, Dr. CHAPMAN, Associate Professor ANDERSON, Assistant Professor CLARK and Dr. TORREY.

Chemistry. — I. Major courses for the degree of master of science. Students will be required to take Courses 101, 108 to 114. In addition to this the requirements in the various thesis subjects are: —

ORGANIC AND BIO-CHEMISTRY. — Courses 115 and either 105, 106 or 107, and 6 hours for one term selected from Courses 103 (b) and (f), and 104.

ANALYTICAL AND INDUSTRIAL AGRICULTURAL CHEMISTRY. — Courses 116, 103 (6 hours), and 6 hours for one term selected from Courses 102, 104 to 107.

PHYSICAL CHEMISTRY. — Courses 104, 117, and 6 hours for one term selected from Courses 102, 103, 105 to 107.

AGRICULTURAL CHEMISTRY. — Courses 103 (6 hours), 118, and 6 hours for one term selected from Courses 102, 104 to 107.

The candidate must pass a final written and oral examination before the Department of Chemistry upon undergraduate Courses 1 to 80, inclusive, and upon all graduate work taken in chemistry by him.

II. Major course for the degree of doctor of philosophy. Students will be required to take Courses 101 to 114, and one course selected from 115 to 118. In addition, the student may be required to spend at least two terms or one semester at some other recognized institution pursuing graduate work in chemistry. The candidate must pass a final written examination before the Department of Chemistry, and an oral examination before the graduate staff, upon the whole field of chemistry, and must be especially well prepared in the lines of work covered by his research.

III. Minor course for the degrees of master of science and doctor of philosophy. Students will be required to take work totaling at least 25 credits. This may be selected from any of the undergraduate Courses 27 and 51 to 80, or any of the graduate courses for which the student is prepared. In addition, the candidate must pass a final written and oral examination before the Department of Chemistry upon the courses taken and upon undergraduate Courses 27 and 51 to 80.

The following is a list of the courses: —

101. INORGANIC PREPARATIONS. — Laboratory. The preparation of chemical products from raw materials. The manufacture and testing of pure chemicals. The laboratory work is essentially synthetic in nature, and is designed to aid in acquiring a more adequate knowledge of inorganic chemistry than is to be obtained by chemical analysis alone. Ten to fifteen of the preparations given in Biltz's "Laboratory Methods of Inorganic Preparations" will be made by each student. Any term, 6 hours.

Mr. SEREX.

102. ADVANCED INORGANIC PREPARATIONS. — Laboratory. Continuation of Course 101. Any term, 6 hours.

Mr. SEREX.

103. ADVANCED ANALYTICAL CHEMISTRY. — Laboratory. This course may be taken in part as follows: (a) electrolytic analysis, 6 hours; (b) ultimate analysis, 6 hours; (c) special analytical work to meet the needs of the individual student, 6 hours. In addition, parts of undergraduate Courses 61, 62, 76 and 77 may be taken, as follows: (d) fertilizers, 6 hours; (e) insecticides, 6 hours; (f) milk and butter, 6 hours. (a), (b), (c) may be taken any time; (d), (e), (f) must be taken at the time the undergraduate course is given.

Professor WELLINGTON and Professor PETERS.

104. ADVANCED PHYSICAL CHEMISTRY. — Laboratory. Measurement of the electrical conductivity of solutions; degree of ionization; ionization constants; per cent hydrolysis of aniline hydrochloride from conductivity measurements; solubility product by the conductivity method; velocity of saponification by conductivity; neutralization point by conductivity; vapor pressure determinations; critical temperature of carbon dioxide or sulphur dioxide; transport numbers; preparation and properties of colloidal solutions; transition points by dilatometric method; heat of solution of ammonium chloride and potassium nitrate; adsorption of iodine by charcoal; splitting of racemic glycerinic or racemic tartaric acids into their optical components. To each student separate work will be assigned. Any term, 6 hours.

Mr. SEREX.

105. ADVANCED ORGANIC PREPARATIONS. — Laboratory. The preparation of compounds not included in Courses 51 and 52, such as the Kolbe synthesis of salicylic acid; benzophenone and Beckmann's rearrangement; rosaniline, malachite green, congo red, indigo and other dyes; synthesis of fructose; Grignard reaction. Barnett, Cain and Thorpe, Gatterman, Noyes, Fischer and other laboratory guides are used. To each student separate work will be assigned. Any term, 6 hours.

Professor CHAMBERLAIN.

106. ADVANCED BIO-CHEMISTRY. — Laboratory. The hydrolysis of proteins and isolation of the amino acids; the study of milk, blood and urine; dietary and digestion studies. References: Abderhalden, Plimmer, Sal-kowski, Hawk, etc. To each student separate work will be assigned. Any term, 6 hours.

Professor CHAMBERLAIN.

107. INDUSTRIAL ORGANIC CHEMISTRY. — Laboratory. The preparation, on a large scale, of wood alcohol, acetic acid, ethyl alcohol, benzene and cellulose products, such as mercerized cotton and artificial silk. References: Molinari, Rodgers and Aubert, Thorpe, Enzyklopädie der tech. Chemie, etc. To each student separate work will be assigned. Any term, 6 hours.

Professor CHAMBERLAIN.

108. THEORETICAL CHEMISTRY. — Lectures. The following topics are considered: the compressibility of the atoms; the structure of atoms; the electron conception of valence. First term, 1 hour. Given in 1917-18. Alternates with Course 109.

Professor PETERS.

109. ANALYTICAL CHEMISTRY. — A general survey of methods and technique covering processes commonly carried out in the laboratory. Gooch's Quantitative Analysis is used as a text. First term, 1 hour. Given in 1916-17. Alternates with Course 108.

Professor PETERS.

110. ORGANIC CHEMISTRY. — Lectures. Some of the following topics will be considered both theoretically and industrially: alkaloids, synthetic dyes, essential oils, terpenes, rubber, etc.; the study of methods for carrying out general reactions; isomerism, tautomerism, condensation, etc. References, Cain & Thorpe, Cohen, chemical monographs, Lassar-Cohn, Heinrichs, Molinari. Second term, 1 hour. Given in 1916-17. Alternates with Course 111.
Professor CHAMBERLAIN.

111. BIO-CHEMISTRY. — Lectures. Some of the following topics will be considered both chemically and physiologically: fats, cholesterol, lecithin, carbohydrates, amino acids, proteins, urea, uric acid, purine bases, enzymes, fermentation, animal food and nutrition, photosynthesis. References, Monographs on Bio-Chemistry, Abderhalden, Plimmer, Haas & Hill, Lewkowitsch, Fischer, Euler, Mathews, Czapek. Second term, 1 hour. Given in 1917-18. Alternates with Course 110.
Professor CHAMBERLAIN.

112. THEORETICAL AND PHYSICAL CHEMISTRY. — Lectures. The relation between the constitution and properties of compounds; mutarotation; steric hindrances; stereoisomerism of other elements than carbon; molecular association; similarity between the compounds of silicon and carbon. Third term, 1 hour. Given in 1917-18. Alternates with Course 113. Mr. SEREX.

113. THEORETICAL AND PHYSICAL CHEMISTRY. — Lectures. Radioactivity; the application of physical chemistry to industrial chemistry. Third term, 1 hour. Given in 1916-17. Alternates with 112. Mr. SEREX.

114. SEMINAR. — Conferences, reports or lectures. Three terms, twice a month, 1½ hours. Professor LINDSEY.

115. RESEARCH IN ORGANIC AND BIO-CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by amount of work done. Professor CHAMBERLAIN.

116. RESEARCH IN ANALYTICAL OR AGRICULTURAL INDUSTRIAL CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by the amount of work done. Professor WELLINGTON and Professor PETERS.

117. RESEARCH IN PHYSICAL CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by amount of work done. Mr. SEREX.

118. RESEARCH IN AGRICULTURAL CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by amount of work done. Professor LINDSEY and EXPERIMENT STATION ASSOCIATES.

Entomology (Major Courses, Ph.D. Degree). — 1. MORPHOLOGY. — Lectures on all, and laboratory work on a portion of the following subjects: embryology and polyembryony; transformations; external morphology; his-

tology; phylogeny; hermaphroditism; hybrids; parthenogenesis; pedogenesis; heterogeny; chemistry of colors; coloration; luminosity; deformities; variation.

2. **ECOLOGY.** — Lectures and laboratory work as above on the following subjects: dimorphism; polymorphism; protective devices; mimicry; insect architecture; plant fertilization; insect products; geographical distribution; methods of distribution; migration; geological history; insects and disease; enemies of insects, vegetable and animal; duration of life; experimental entomology and insect behavior.

3. **ECONOMIC.** — Lectures and laboratory work as above on the following subjects: special methods of control; insecticides; special research; insect photography; methods of preparing illustrations; field work and life-history investigations; insect legislation; methods of record keeping.

4. **SYSTEMATIC.** — Lectures and laboratory work as above on the following subjects: history of entomology; classifications and principles of classification; nomenclature and its rules; how to find and use literature; preparing indices; number of insects known and in existence; lives of prominent entomologists; methods of collecting, preparing, preserving and shipping insects; important collections; location of types.

5. **SEMINAR.** Required readings; thesis.

All of these five courses are required of students taking a Ph.D. in entomology.

Minor Courses. — Such portions of the major courses as are most closely correlated with the other lines of work taken by the student and which can be completed in the time available.

Professor FERNALD, Professor CRAMPTON and Associate Professor REGAN.

Horticulture. — Graduate work is offered in various lines of horticulture. For the most part this is divided into the different departments which now constitute the college Division of Horticulture, as follows: pomology, floriculture, landscape gardening, forestry and market gardening. For work in these lines application should be made direct to the heads of the several departments.

Besides this work, however, opportunity is offered for graduate study in general horticulture, including topics from the several organized departments mentioned, and also questions relating to plant breeding, general evolution, propagation, manufacture of horticultural products, etc. This general work is under the direction of Prof. F. A. Waugh, head of the Division of Horticulture.

Landscape Architecture (Major Course). — Every student before receiving his master's degree in landscape gardening must have given some thorough and fruitful study to each of the following five departments. As far as possible these studies must be of a practical nature, *i.e.*, they must be made upon actual projects in progress of development.

1. **THEORY.** — The principles of esthetics as applied to landscape gardening.

2. **DESIGN.** — The principles of pure design and their application in landscape and garden planning.

3. **CONSTRUCTION.** — The practical methods of carrying out landscape plans, laying out, equipment, organization of working force, time and cost keeping, etc.

4. MAINTENANCE. — Methods, organization, cost.

5. PRACTICE. — Office work, drafting, estimating, reporting, charges, accounting.

Qualifications. — Each student before he may receive the master's degree with a major in this department must convince his instructors that he has a genuine aptitude for some branch of landscape gardening, either in design, construction or management.

The minimum period of graduate study will be one and one-half years. At least one year of this time must be spent in residence at the college, and also one year must be spent in practice outside the college. The work done outside the college may be prescribed by the department, and must be fully reported to the department in writing. It is essential, further, that the candidate secure the written approval of his employers outside the college. The department may, at its discretion, require a longer period of study at the college or a longer apprenticeship outside the college.

Thesis or Project. — Each student before receiving the master's degree with a major in landscape gardening must present a satisfactory thesis or complete project. A thesis will consist of a careful original study of some problem in landscape architecture, presented in typewritten form with any necessary illustrations, such as photographs, diagrams, drawings, etc. A project will consist of a completed set of studies of some suitable landscape-gardening problem, such as the design of a park, a real estate subdivision, an extensive playground. Such a project will usually consist of —

(a) Original surveys, including topography.

(b) Block plans, showing original design.

(c) A rendered plan or plans of the main features.

(d) Detailed working drawings.

(e) Estimates of cost.

(f) Complete report and letter of transmittal.

Minor Course. — Any student electing a minor in landscape gardening will be directed to take such courses from the regular catalogue list as may seem most suitable for him. Under ordinary circumstances no other work will be given to students electing minors. In special cases, however, individual problems will be assigned and individual instruction given. These exceptions will be made in cases where, by so doing, it is possible to give the student material assistance in the plan of his major work.

Prerequisite Work. — The undergraduate courses in the college known as Landscape Gardening 50, 51, 52 and 53, Drawing 25, 26, 27, Horticulture 27, 50, 51, and Mathematics 26 and 27 will be considered prerequisite to graduate work, and any student not having passed these courses or their equivalent will be required to make up such work without graduate credit. Courses known as Landscape Gardening 75, 76, 77, 78 and 79 are required and may or may not be accepted for graduate credit, at the discretion of the department.

Microbiology. — I. COURSES LEADING TO THE DEGREE OF DOCTOR OF PHILOSOPHY. — 1. The candidate must present twenty-five credits from the undergraduate study as furnished in undergraduate Courses 50, 51, 52, 80, 81 or an equivalent before he can enter upon graduate study.

Note. — Twenty-five credits are required of undergraduates majoring in microbiology.

2. The candidate must pursue successfully the following special courses or

their equivalent. These courses are designed to give a comprehensive survey of the fields indicated, and are arranged especially for graduate students.

175. Agricultural microbiology, ...	5 credits.
176. Agricultural microbiology, ...	5 credits.
182. Dairy microbiology, ...	5 credits.
183. Food microbiology, ...	5 credits.

Note. — Courses 175, 176, 180, 181, 182, 183 correspond in subject-matter with Courses 75, 76, 80, 81, 82, 83 of undergraduate study; the latter courses are elementary in nature, while the former are arranged for intensive advanced study of graduate character. Candidates will be required not only to perform the exercises of the above courses, but will be expected to assist in teaching the elementary classes covering the same theme as a part of graduate requirements.

3. It will be necessary to complete additionally the following courses or their equivalent, open only to graduate students:—

190. I. 1917. Studies in technique, as photomicrography, laboratory equipment and manipulation. ¹	Associate Professor ITANO.
5 to 10 credits.	
151. II. 1918. Cytological and morphological studies and technique. ¹	Professor MARSHALL and Mr. HOOD.
5 to 10 credits.	
152. III. 1919. Physiological studies. ¹	Associate Professor ITANO.
5 to 10 credits.	
177. II. 1919. Microbial studies in agriculture. Specific subjects. ¹	Professor MARSHALL, Associate Professor ITANO and Mr. HOOD.
5 to 10 credits.	
181. II. 1920. Advanced sanitary or hygienic studies. ¹	Professor MARSHALL and Associate Professor ITANO.
5 to 10 credits.	
150. I., II., III. Lectures and study of literature. ²	Professor MARSHALL, Associate Professor ITANO and Mr. HOOD.
10 credits.	
200. I., II., III. Research. ³ (Some microbiological problem related to agriculture.)	Professor MARSHALL, Associate Professor ITANO and Mr. HOOD.
40 to 50 credits.	

The thesis prepared must be satisfactory to the department and the graduate staff, and the candidate must be ready to defend it at his public examination. Further, following the presentation of the thesis, the candidate must submit to a written examination covering the entire subject by the department and a public oral examination under the auspices of the graduate staff.

II. COURSES LEADING TO THE DEGREE OF MASTER OF SCIENCE. — 1. Prerequisite studies, as in the case of the degree of doctor of philosophy (I., 1).

2. Special studies as represented by courses —

175. Agricultural microbiology, ...	5 or 10 credits.
176. Agricultural microbiology, ...	5 or 10 credits.
182. Dairy microbiology, ...	5 or 10 credits.
183. Food microbiology, ...	5 or 10 credits.

3. Courses designed for graduate students only.

150. I., II., III. Lectures and study of literature.	Professor MARSHALL, Associate Professor ITANO and Mr. HOOD.
5 credits.	
200. I., II., III. Research. ³ (Some microbiological problem related to agriculture.)	Professor MARSHALL, Associate Professor ITANO and Mr. HOOD.
15 to 25 credits.	

¹ Repeated every three years.

² Continues over three years, once each week.

³ Distributed as may be most beneficial for research work. Time and credit by arrangement.

The thesis submitted must be satisfactory to the department and to the graduate staff.

The candidate will be required to take a written examination and an oral examination by the department.

III. MINOR WORK IN MICROBIOLOGY. — May consist of Undergraduate Courses 50, 51, 52, and one other course, designed to support his major work, from among Courses 175, 180, 181, 182, 183. He will also be required to pursue Graduate Course 150 through four terms (see II., 3, 150). In case the candidate has had some of these courses he will be required to take more advanced substitute courses. A written examination over the subject-matter covered will be given at the close of the work.

Poultry Science (Major Course for the Degrees of M.S. and M.Agr.). —

1. READING. — A review of the entire field of poultry literature, covering books, bulletins and special articles, is made, and a written report on one or more subjects required.

2. SEMINAR. — A critical review and a criticism of the more important experiments carried on at the various stations in this and other countries; also a study of poultry conditions in foreign countries, methods of management, etc., besides a detailed study of some of the largest poultry projects in this country.

3. ANATOMY (GROSS AND HISTOLOGICAL), PHYSIOLOGY AND SURGERY. — This course requires a careful study of the anatomy and physiology of the fowl. Special attention is given to a study of those structures concerned with practical poultry problems. Instruction in surgical technique, adapted to fowls, may also be given.

4. BREEDING. — The student will carry on such breeding experiments as time and facilities permit. He may also do work in connection with our regular experimental projects. A detailed study of the pertinent literature will be required. Animal Husbandry 5, or its equivalent, is a prerequisite.

5. FEEDING. — A study of the relation of various foods and other substances to the morphology and physiology of the bird, with special reference to such subjects as egg production, feather form and structure, condition of flesh, bone, etc.

6. BROODING. — Studies will be made upon the relation between viability and rate of growth and the following topics: type of brooder, number of chicks in brood, ventilation, humidity, sanitation, exercise and weather conditions; also a comparison of natural methods with artificial methods of rearing chicks.

7. INCUBATION AND EMBRYOLOGY. — A number of problems of a practical, scientific and mechanical nature relating to incubation are considered. The work in embryology is of an advanced nature dealing with its relation to morphogenesis and heredity, and presupposes an elementary knowledge of the embryology of the chick.

8. POULTRY DISEASES AND SANITATION. — In this course a study is made of various problems in poultry sanitation, with particular reference to methods relating to the control and eradication of disease.

9. THESIS. — A thesis based on first-hand work on some problem in poultry biology or husbandry is required of all students working for the M.S. degree, and may be required of those working for the M.Agr. degree.

Note 1. — The postgraduate course presupposes all undergraduate work or its equivalent, together with practical experience. Without the latter, students will be unable to handle Courses 5, 6 and 7. At the discretion of the instructor

in charge, graduate students may be required to pursue undergraduate courses in other departments without credit.

Note 2. — Practical poultry work may be required, but no credit will be given for such work.

Note 3. — Courses 1 and 2 are designed particularly for minors.

Rural Sociology. — Courses are offered in Rural Sociology as major or minor subjects for the degree of doctor of philosophy.

Candidates for the master's degree will be required to pass an examination in all courses offered by this department primarily for undergraduates, as shown in the departmental classification. In addition they will be required to select one or more of the divisions of the subject for intensive study and research, as indicated below.

A thesis showing the results of personal investigation on some particular topic or topics must be presented. The thesis must show familiarity with the material bearing on the subject, ability in discovering and utilizing original sources, judgment in evaluating facts, evidences and authorities, originality and independence of thought. It must be a contribution in a very definite way to rural sociological thought.

TOPICS FOR STUDY AND RESEARCH.

1. The rural community: —
 - (a) Historical development.
 - (b) Influence of modern conditions on family and community life.
 - (c) Problems and methods in community organization.
 - (d) Community planning in Massachusetts.
2. Origin and development of rural institutions: —
 - (a) Scope, function and influence of educational institutions on rural social progress. Plans for betterment.
 - (b) History of the development of the rural church, its problems and program for improvement.
 - (c) The farm family, in its relation to religious, cultural, educational and social agencies. The relation of the standard of living to rural social progress.
3. Rural organization: —
 - (a) The scope and function of rural organization in development of rural life.
 - (b) Work of the national government in rural organization.
 - (c) County and institutional work in rural organization.
 - (d) Leadership in its relation to organization.
4. Rural government and rural law: —
 - (a) Development of rural local government in New England and the west. Progress in efficient local self-government.
 - (b) Relation of the State to the farmer, influence of the farmer in legislation, the organized ways and means by which the State aids the farmer directly.
 - (c) Work of the national government in its relation to the social welfare of the farming people.
 - (d) Agrarian legislation in the United States and Europe affecting rural social welfare.
5. Farmers' organizations: —
 - (a) Social problems underlying farmers' organizations in reference to service and permanency.
 - (b) Principles of organization.
 - (c) History of farmers' organizations in the United States.
6. Rural social and sociological surveys: —
 - (a) An intensive study of the place and function of statistical data in the sociological field, its evaluation and interpretation.
 - (b) A critical study of social surveys of rural life and methods of survey, with a view to discovering the strength and weakness of each.
7. Social condition of the rural people: —
 - (a) Origin and development of rural ideals.
 - (b) The status of the rural people in relation to health, morality, crime, etc.
 - (c) Problems of social psychology arising in rural life.

The course required for candidates offering a minor will be arranged after a conference with the director of the department, and will take into consideration the needs of the student in view of his previous preparation. The amount of time required of the student for his minor work will correspond with the requirements of the graduate school.

Veterinary Science. — Work is available in anatomy, hygiene, veterinary pathology, medicine, surgery, parasitology and other special lines or divisions of the subject.

Zoölogy. — Courses in zoölogy may be available as a minor for the degree of master of science and as a minor for the degree of doctor of philosophy. The nature of the work will necessarily vary according to circumstances, and may be intensive in a special field and correlated closely with the major work of the student, or it may be of a more general character, depending on the student's needs or previous acquaintance with general zoölogical science. The time devoted to zoölogy as a minor for either of the above-named degrees may vary from 12 to 16 hours per week, pursued for a year and a half.

LIST OF STUDENTS.

A list of the degrees conferred in the Graduate School, and of the students enrolled, is given in the general lists at the end of the volume.

THE SHORT COURSES

THE SHORT COURSES.

The short courses offered by the Massachusetts Agricultural College are designed to meet the needs of those, both young and old, who cannot come to the college for the regular agricultural courses. They furnish the student with instruction in modern accepted methods and are planned to help the farmer and the housewife.

The short courses include:—

- A. The Two-year Course in Practical Agriculture.
- B. The Ten Weeks' Winter School.
- C. The Summer School.
- D. The Vocational Poultry Course.
- E. The One-year Rural Engineering Course.
- F. The Regional School.

REQUIREMENTS FOR ADMISSION TO SHORT COURSES.—Students must be at least seventeen years of age and must furnish satisfactory evidence of good moral character. References are required. There are no entrance examinations. The sole test is ability to do the prescribed work. Students enrolling for the Two-year Course in Practical Agriculture must have at least a common school education.

EXPENSES OF SHORT COURSES.—The expense of attending any of the short courses is approximately as follows:—

Furnished rooms in private houses (per week), ...	\$2 to \$4
Board at college dining hall (per week), ...	\$6.50
Board with private families (per week), ...	\$6.50 to \$9
Registration fee (Ten Weeks' Winter School), ...	\$5

Tuition in all the short courses is free to residents of the Commonwealth. Small laboratory fees are charged in some of the courses.

A. TWO-YEAR COURSE IN PRACTICAL AGRICULTURE.

The Two-year Course in Practical Agriculture is offered to meet the needs of students who for one reason or another cannot take the four-year college course. It is designed to provide the largest amount of practical information and training in agriculture and horticulture in the shortest possible time consistent with thoroughgoing work. This course is open to men and women seventeen years of age or over who have at least a common school education. The Two-year Course in Practical Agriculture was organized in 1918, the first term beginning December 2 and continuing for a period of four months. Owing to the fact that young men of eighteen were subject to military service, students of sixteen years of age were admitted during this year. It was deemed inadvisable while war conditions prevailed to offer more than a four

months' term, in order that students might return to the farm in time for the spring work. All subjects offered during this four months' term were made elective. Thirty-seven students were enrolled during the first year. The value of such a course to the State is shown by the fact that 210 students enrolled in 1919.

The course as now organized makes available to the student three courses in agronomy, five courses in animal husbandry, five courses in fruit growing, six courses in rural engineering, five courses in dairying, four courses in poultry, four courses in rural home life, one course in farm manufacturing, three courses in forestry, four courses in farm business, one course in hygiene and sanitation, one course in English, three courses in vegetable gardening, three courses in floriculture, one course in insect pests and two courses in botany. The advantages of the college staff of specialists and the college plant with all its resources are thus made available to young men and young women who may not have had the opportunity of securing a high school education.

This course will appeal not only to young men and women, but also to men and women of mature years and practical experience who wish to know more about the business of farming. Although the course is planned to meet the needs of those who are not graduates of high schools, the instruction is not preparatory or elementary in its nature, but is so arranged that it will be of value to all. The greater amount of academic training that some of the students may possess will in a measure be offset by the fund of practical knowledge possessed by many who have completed only the elementary schools.

The Two-year Course in Practical Agriculture is so arranged that the student receives instruction in fundamental subjects and is given an opportunity to select the lines of work during the second year in which he is particularly interested.

The first year consists of six months of study at the college. The term begins with the college fall term and closes with the winter term of the regular session. The same vacation periods are observed as in the regular four-year course. The student pursues during the first year two courses in soil fertility, two courses in animal husbandry, two courses in fruit growing, one course in farm machinery, one in shop mechanics, one in dairying, one in poultry, one in farm structure, one in hygiene and one in farm law.

At the close of six months of study, students are required to gain six months of farm experience. The college will assist students in finding positions and in placing them on farms where the experience gained will be of great advantage. Thus, an effort will be made to place on a dairy farm the man expecting to take up dairying as his chief line of work, and a student of pomology on a fruit farm.

During the second year the student spends nine months in resident study. Courses in plant diseases, crops, insect pests, feeding, farm management, marketing and farm problems are required of all students.

In addition, the student selects from the following list of subjects three which he will carry throughout the year: fruit growing, dairying, poultry husbandry, vegetable gardening, floriculture and rural home life.

During the winter and spring terms of the second year there are elective subjects from which the student may complete his program. These courses include: breeding, animal diseases, gas engines, dairying, carpentry, drainage and irrigation, agricultural credit, farm manufacturing and dairy bacteriology.

The course is not intended for students enrolled in high schools. Such students should finish the high school course. Students enrolled in high schools who wish to take the course should bring a statement either from the principal of the high school or from parent or guardian asking permission to be enrolled.

There are no entrance examinations or entrance conditions other than that students must be seventeen years of age or over and have completed the elementary or common schools. They must have had six months' practical farm experience before they will be permitted to enroll for the work of the second year. This experience may be gained after the first year of study at the college.

Each student is required to file with the treasurer of the college a statement, signed by the town (or city) clerk of the town (or city) from which he enrolls, stating that the parent or guardian of the student is a resident of that town.

POSITIONS. — While the college does not guarantee positions it frequently has calls for capable, energetic men and women with farm experience. The demand for students to fill positions has been greater than the supply. The opportunity for farm positions is exceptionally good.

CERTIFICATE. — All students will receive a certificate showing their standings in courses in which they were registered. Credits earned in the Two-year Course in Practical Agriculture or in any other of the short courses do not lead to the college degree. Students who possess college entrance requirements and who wish to take the regular college work should address the registrar of the college.

SCHOLARSHIPS. — In connection with the Two-year Course in Practical Agriculture the New England Branch of the Woman's National Farm and Garden Association offered five scholarships of \$100 each, available to women electing agricultural courses.

TUITION AND FEES. — Tuition is free to residents of the Commonwealth. Students who are not residents of Massachusetts pay a fee of \$20 a term.

B. THE WINTER SCHOOL.

The Winter School, beginning usually about January 1 and continuing for ten weeks, was started several years ago and has always been very popular, not only with more mature farmers and their wives, but with young men and women who control or manage farms. The courses, though short, are very practical in their nature, and are so arranged that a student may choose such subjects as will enable him to specialize along the line of work in which he is most interested. There is a wide range in the choice of subjects, making it possible for the student to take work for several winters in succession. Many college graduates enroll for the Winter School.

SCHOLARSHIPS. — The Jewish Agricultural and Industrial Aid Society of New York has instituted a system of free scholarships to enable the children of Jewish farmers to attend the short winter course in the States in which they reside. The stipend is sufficient to pay all the expenses of the holder for the course; such expenses usually amount to from \$100 to \$150. The following courses are offered: —

OUTLINE OF THE TEN WEEKS' WINTER SCHOOL, DECEMBER 30 TO MARCH 5.

- Soil Fertility. Professor BEAUMONT. Three lectures a week.
- Field Crops. Assistant Professor COOPER. Two lectures and one two-hour laboratory period per week.
- Types and Breeds of Livestock. Professor McNUTT. Three lectures and two two-hour laboratory periods a week.
- Livestock Feeding. Professor McNUTT. Three lectures per week.
- Animal Breeding. Professor McNUTT. One lecture and one two-hour laboratory period per week.
- Dairying. Professor LOCKWOOD and assistants. Five lectures and five laboratory periods per week.
- Dairy Bacteriology. Professor MARSHALL. Two lectures and one two-hour laboratory period per week.
- Animal Diseases and Stable Sanitation. Professor PAIGE. Two lectures per week.
- Poultry Husbandry. Mr. DEAN. Five lectures and one two-hour laboratory period per week.
- Fruit Growing. Professor SEARS. Three lectures and one two-hour laboratory period per week.
- Market Gardening. Associate Professor DACY. Three lectures and two two-hour laboratory periods per week.
- Floriculture. Associate Professor THAYER and Mr. WHITING. Five lectures per week.
- Horticultural Manufacture. Professor CHENOWETH. Two lectures and two laboratory periods per week.
- Farm Management. Assistant Professor ABELL. Two lectures a week.
- Farm Accounts. Assistant Professor ABELL. Two two-hour laboratory periods per week.
- Marketing. Professor CANCE and assistants. Two lectures a week.
- Agricultural Credit. Professor CANCE and assistants. Two lectures a week.
- Botany. Assistant Professor McLAUGHLIN. Two lectures a week.
- Entomology. Associate Professor REGAN. Three lectures per week.
- Farm Structures. Assistant Professor STRAHAN. Two lectures and one two-hour laboratory period per week.
- Farm Machinery. Professor GUNNESS. Two lectures and three two-hour laboratory periods a week.
- Rural Sanitary Science and Hygiene. Professor MARSHALL. Two lectures per week.
- Vocational Guidance. Miss HAMLIN. One lecture per week.
- Foods. Miss SKINNER. One lecture and two two-hour laboratory periods per week.
- Clothing. DEPARTMENT OF HOME ECONOMICS. One lecture and two two-hour laboratory periods per week.
- The Business of the Household. Miss SKINNER. Three class hours per week.
- Home Care of the Sick. Miss SKINNER. Three class hours per week.
- Principles and Methods of Vocational Agricultural Teaching. Professor HART. Five exercises per week.
- Special Methods in Vocational Agricultural Teaching. Professor WELLES. Five exercises a week.
- Professional Improvement Problems. Mr. HEALD. Five periods per week.

C. THE SUMMER SCHOOL.

The 1919 Summer School was under the joint direction of the Massachusetts Agricultural College and the Massachusetts Board of Education. Twenty-five courses were offered in agriculture and horticulture, and nineteen courses in education. The enrollment was the largest in the history of the college.

The plan of co-operation of the Massachusetts Agricultural College and the Massachusetts Board of Education will be followed during the 1920 Summer School. More courses in agriculture, horticulture and education will be offered, in order that teachers who attended the 1919 Summer School may take advantage of another summer's work.

D. ONE-YEAR VOCATIONAL COURSE IN POULTRY HUSBANDRY.

PURPOSE. — This course is designed for graduates of the agricultural vocational schools and others who wish to prepare themselves for practical poultry keeping, and can spend only one year at college.

SCOPE. — The work covers seven detailed courses in poultry husbandry, as well as short-course work in fruit growing, market gardening, animal husbandry, or other subjects that will be helpful to poultry raisers. In addition to classroom and laboratory exercises each student is required to put in from twenty-five to thirty hours per week at the plant in the care and management of poultry, for the purpose of becoming proficient in the various branches of the work.

ENTRANCE REQUIREMENTS. — Applicants must be at least eighteen years of age and have a good elementary education.

FEES. — There is no tuition for residents of Massachusetts, but a laboratory fee of \$5 is required for both the fall and spring terms.

NOTE. — The course is limited to 16 students. Plans are now being made to begin the one-year poultry course next year in December, to continue until the following December.

E. THE ONE-YEAR RURAL ENGINEERING COURSE.

The One-year Course in Rural Engineering was organized at the college in 1919. This course offers instruction in drawing, English, farm machinery, forge shop, gas engines, mathematics and physics. The course is designed for men who wish to specialize in the study of farm machinery. It is open to every one eighteen years of age or over who has completed a common school education.

The subjects are arranged as follows: —

<i>First Term</i>	<i>Second Term</i>	<i>Third Term</i>
Gas Engines, . . . 5	Gas Tractors, . . . 5	Gas Tractors, . . . 5
Farm Machinery, . . . 3	Forge Shop, . . . 2	Forge Shop, . . . 2
Mechanical Drawing, . . 3	Farm Accounts, . . . 2	Farm Management, . . 3
Vocational Mathematics, 2	Vocational Mathematics, 2	Vocational Mathematics, 2
Elective.	Elective.	Drainage and Irrigation, 3
		Elective.

F. THE REGIONAL SCHOOL.

There has been a constant demand for a school of from four to six weeks in connection with some other educational institution located in the eastern part of the State, in or near Boston, by means of which short practical courses in agriculture might be presented.

THE EXTENSION SERVICE

THE EXTENSION SERVICE.

The Extension Service of the Massachusetts Agricultural College is an organized effort to carry systematic and practical instruction to the thousands of people throughout the State who are unable, owing to various reasons, to take advantage of the regular courses offered at the college. It is in reality the "carrying of the college to the people of the State." Every department of the institution, in so far as the regular teaching and research work will permit, contributes what it can to this work. There is also a regular staff of extension workers whose business it is to present the instruction of the college to individuals and various educational organizations, such as extension schools, granges, Y. M. C. A.'s, churches, boards of trade, etc., throughout the State, in addition to giving county farm bureaus assistance in their project work. Extension work includes the following: extension courses at the college; home study courses; itinerant instruction, including lectures and lecture courses, exhibits, demonstrations and extension schools; extension work through the various departments of the college, in which the extension specialist is responsible to the head of the department for the technique of the work and to the director of the Extension Service for its accomplishment; co-operative work of various kinds with the United States Department of Agriculture; and extension work through county, district and local agents. Some of the ways in which this is being done are briefly described below.

COURSES AT THE COLLEGE.

Courses of the duration of one week or under are managed by the Extension Service, and include, in the winter, programs for special agricultural interests or organizations, and, in the summer, the big summer Farmers' Week.

THE WINTER COURSES. — These courses are arranged to meet the demand for a short course of instruction on agricultural subjects, requested by such interests as the State institutional managers and various live-stock, crops, tobacco, fruit and market-gardeners' associations. A sheep-shearing contest is also arranged for the sheep breeders' association. Instruction is presented by lectures, demonstrations and conferences. The college equipment is available for use, and the subject-matter may be selected or suggested by those expecting to attend. The work of the college faculty may be supplemented by lectures and demonstrations by eminent men and women from our own and other States. No fee is charged.

SUMMER FARMERS' WEEK. — The first summer Farmers' Week was held at the college July 28 to Aug. 2, 1919, and was instituted to meet the demand for an opportunity to see the actual outdoor work of the college farm and experiment station, and to see the college teaching put into practice in the field. As the winter meetings of necessity are confined to indoor lectures and demonstrations, the summer Farmers' Week places the emphasis on out-

door work, and limits the program to one or two lectures a day. The greater part of the time is devoted to personally conducted field trips to all parts of the college property. Various agricultural organizations have field days at the college during the week, and every available facility for their entertainment is placed at their disposal. Farm bureaus, agricultural organizations and individual farmers co-operate in supplying requested information as to the probable subject-matter which visitors desire on the program. With the program for the week is furnished a detailed map of the college property, and, with the signs and guideposts which are numerous displayed to explain various features, the services of a guide are not required to see what is desired.

The 1919 summer Farmers' Week attracted an exceptionally large crowd to the college from every county in the State and many from out of the State, and with the new features anticipated for the 1920 event, even greater interest is expected.

ANNUAL CONFERENCE OF COUNTY AGENTS AND VOCATIONAL AGRICULTURAL INSTRUCTORS. — In December of each year a one-week conference of county agents and vocational agricultural instructors is held at the college. This is for the purpose of correlating the extension work throughout the State, and to enable the field workers to keep in up-to-the-minute touch with agricultural problems, methods and research as conducted in Massachusetts as well as other States in this particular section of the country. The next annual conference will probably be held during the third full week in December, 1920.

POULTRY CONVENTION. — The annual poultry convention, now included as one of the main events on the program of summer Farmers' Week, is the most important meeting in the State for the poultry public. Men of national reputation are secured for this occasion. In preparing the program, the wishes and needs of the poultry men and women are given first consideration, and topics of the most timely interest are listed for discussion by the best-informed authorities.

HOME STUDY COURSES. — The purpose of the home study courses is to furnish systematic instruction in those lines which will most benefit the general farmer, the dairyman, the fruit grower, the market-gardener, the poultryman, the teacher, the home maker, and all others who are interested in agricultural and country-life matters. It is the purpose to present up-to-date, accurate and concise information in such a manner and in such language that all who pursue the study may readily understand the work.

Courses offered. — A number of courses are in process of revision and several are being rewritten. During 1920 courses will be available as follows: —

1. Soils and Soil Fertility. Professor BEAUMONT.
2. Manures, Fertilizers and Soil Amendments. Professor BEAUMONT.
3. Field Crops. Assistant Professor JONES.
4. Farm Dairying. Professor LOCKWOOD.
5. Fruit Growing. Professor SEARS, Associate Professor CHENOWETH.
6. Vegetable Gardening: Part I., Market Gardening, Part II., Home Gardening. Prof. H. F. TOMPSON and Prof. GILBERT S. WATTS.
7. Farm Accounts. Professor FOORD.
8. Entomology. Dr. REGAN.
9. Forestry. Professor CLARK.
10. Shade Tree Management. Professor OSMUN.
11. Plant Diseases. Professor OSMUN.
12. Poultry Husbandry. Professor GRAHAM and Professor PAYNE.
13. Home Economics.

Methods of conducting the Work. — The best known methods of conducting correspondence course teaching are employed. Certain courses are based entirely upon text-books, others consist wholly of typewritten lectures, while others combine the two. If books are not required they are usually recommended.

The courses are designed primarily for the individual student, although experience has shown the advantages of the group method of home instruction. Prospective students should endeavor to find four or more others who will enroll in the same or other courses, so that a study class may be formed. Such a method has the advantage of instruction under the guidance of a leader, who is a member of the class. Furthermore, it is usually possible for the Extension Service to send a speaker to the class two or three times during the term to help the members of the group with their individual problems. The college library will also arrange for the loan of books to be used as text and reference reading.

Enrollment of Home Study Courses. — Students may enroll in the courses at any time between October 1 and June 1, and one year from the date of registration is allowed for the completion of each course.

Expenses of the Courses. — In order that none shall enroll except those who are interested and desire to pursue earnest study, a small fee is charged. This has been fixed at \$2 for each course except where the courses are divided, and it has been found advisable to charge \$2 for each of the parts in these instances. The fee is payable strictly in advance, at the time the enrollment card is sent. When text-books are required the student purchases these.

LECTURES AND DEMONSTRATIONS. — The members of the faculty of the college are, when other duties will permit, available for lectures and demonstrations before granges, men's clubs, women's clubs, Y. M. C. A.'s, farmers' clubs, boards of trade and other organizations. Organizations arranging the lectures are asked to pay the traveling expenses of the lecturer, provided no admission fee is charged. When admission is charged the lecturer is entitled to a fee in addition to traveling expenses.

EXTENSION SCHOOLS. — Agricultural extension schools dealing with the production side of farming and with the problems of the farm home are offered to communities where there is the desire to have the college brought to the community. The college sends a corps of instructors and the necessary equipment to put on a program of instructional work in live-stock, crops, soils, fruits, market-gardening, poultry or farm management and home makers' courses for women. Communities desiring an extension school make a written request, agreeing to defray all local expenses, such as the rent, heating and lighting of a suitable hall, and the board of the instructors during the school. Information can be obtained by writing to the Extension Service of the Massachusetts Agricultural College.

EDUCATIONAL EXHIBITS AT FAIRS AND OTHER SHOWS. — The college co-operates with the managers of fairs, industrial expositions, corn shows, poultry shows, fruit shows and other exhibitions by making educational exhibits. Where practicable the exhibit is accompanied by lecturers and demonstrators.

EXTENSION WORK IN SPECIAL FIELDS.

EXTENSION WORK IN FRUIT GROWING. — This work includes lectures and demonstrations on laying out and planting orchards, pruning, spraying, thinning, grading, packing and marketing fruits. Demonstration orchards,

new and renovations plots, are established in different sections of the State, under a co-operative agreement between the college and the owners of land. Extension schools in fruit growing and fruit grading and packing are arranged on request. Visits to farms for advisory work are made, and correspondence on orcharding subjects is invited.

EXTENSION WORK IN ANIMAL HUSBANDRY. — The purpose of this work is primarily to acquaint the farmers of the State with improved methods of developing the live-stock industry of the State. This is done by assistance rendered communities of farmers who wish to organize live-stock centers, and also by co-operating with other active educational organizations already established.

Upon request, and where conditions favor the organization of county live-stock clubs, cow testing associations and bull associations, assistance is provided.

Live-stock feeding, breeding and management demonstrations are established in different sections of the State under co-operative agreement between the college and the owners of live stock. Extension schools, involving the selection, housing, general management and marketing of live stock, are arranged on request. Advisory trips to farms are made, and correspondence on subjects relating to live stock is invited.

EXTENSION WORK IN DAIRYING. — This includes lectures and demonstrations on the handling and care of milk, cream, butter and cheese; Babcock testing, dairy utensils and dairy manufactures. Educational campaigns may be arranged in different communities, seeking to educate producers, dealers and consumers as to the production and distribution of clean, safe milk. Through correspondence and personal visits advice is given —

1. To help the improvement of the quality of dairy products.
2. To help in the problem of more economical handling and manufacturing.
3. To help stimulate a larger and continued use of dairy products.

EXTENSION WORK IN POULTRY HUSBANDRY. — In addition to such general activities as lectures, demonstrations, extension schools, exhibits, conferences, farm visits, bulletins and plans for developing poultry plants, the poultry extension practice is to emphasize, each year, two or three urgent needs of the industry in State-wide campaigns aiming to reach all poultrymen of the State.

In co-operation with the several county farm bureaus definite county projects and community programs are arranged; and co-operative work is undertaken with many local poultry associations. Service is also rendered in the diagnosis and control of poultry diseases.

The annual poultry convention on the campus is attended by hundreds of poultrymen.

EXTENSION WORK IN SHEEP HUSBANDRY. — The extension work in sheep husbandry has been conducted along the following project lines: —

I. Service project carried on by —

A. Lectures on —

1. Breeds.
2. Feeding.
3. Care and management.
4. Parasites.

B. Demonstrations of methods of castration, docking, shearing both by shears and machine, preparing the fleece for marketing, dipping and treatment for intestinal parasites, including *post mortem*.

C. Selecting breeding stock for beginners and others.

II. A project having for its object the finding of the cost of carrying on a profitable sheep business.

III. Organizing county sheep breeders' co-operative associations.

IV. Forming boys' and girls' sheep and lamb clubs.

The above lines of work have been carried on during the year. At this writing project II. has not been completed. New calls may open up new projects along the same lines as those now complete. This work is conducted in co-operation with the United States Department of Agriculture.

EXTENSION WORK IN FARM MANAGEMENT, FIELD STUDIES AND DEMONSTRATIONS. — This is carried on co-operatively between the college and the office of farm management of the United States Department of Agriculture at Washington. The work consists of a study of farm conditions, followed by suggestions for handling farm management problems, often involving an adjustment of the different enterprises, such as dairy, orchard or field crops, so as to give economical use of labor and material, and make a profitable business. Specific advice is given upon the planning of farms and farm buildings, the proper farm equipment and the keeping of farm accounts.

EXTENSION WORK IN SOILS AND CROPS. — The subject-matter of this work considers the economical production of crops and the economical maintenance of soil productivity in Massachusetts. The crops adapted to Massachusetts conditions, their relative place in agriculture, their culture, fertilization, etc., are considered.

The work done can be grouped under the following main headings: —

1. Project work, county farm bureaus: —

(a) Assistance in soil and crop problems and in demonstration work.

(b) Assistance at meetings and in work with individual farmers and organizations.

2. Correspondence. Conducting correspondence courses and answering inquiries sent to the college.

3. Lectures and demonstrations at meetings and extension schools.

4. Preparation of exhibit material.

5. Preparation of short articles dealing with timely soil and crop problems.

EXTENSION WORK IN HOME ECONOMICS. — This work includes lectures and demonstrations on subjects pertaining to homemaking. This year special emphasis will be placed on clothing, household management and right food for the family. Instruction is carried on by means of a series of lessons given to groups who are housekeepers and leaders as well. All work is done in co-operation with the county home demonstration agents.

JUNIOR EXTENSION WORK. — This is an organized effort to promote among young people between the ages of ten and nineteen years the study of agriculture and home economics in the home. The work organized by the United States Department of Agriculture is carried on by the college in co-operation with county farm bureaus or improvement leagues. As far as possible the young people are organized into groups or clubs; where this is impossible the work is done with the individual. An endeavor is made to obtain some one in each community to act as a local leader of the club. Many school superintendents find it one means of stimulating enthusiasm

for outdoor life among their pupils. Throughout the State teachers of rural schools use it to tie up the school and home life. City school teachers have found it helpful in finding the rural-minded pupils living under urban conditions. Exhibits held locally or at county and State fairs do much to arouse a wholesome spirit of competition among the members. The State Department of Agriculture and several private organizations appropriate money to further the work. The work is usually introduced by conferences with individuals interested, and lectures before any organization interested in young people and desiring to see the work carried on in any community.

LIBRARY EXTENSION WORK. — This consists principally of loaning to the libraries of the Commonwealth general collections of the latest and best books and bulletins on agriculture and home economics. Smaller collections or package libraries on special subjects, such as fruit harvesting and marketing, dairying, poultry houses, beekeeping, home economics, country schools and other topics, are also sent out.

This material is loaned for a period of eight weeks, subject to renewal when possible. All transportation charges for shipments to or returned from borrowing libraries are paid by the Extension Service. The college library also supplies lists of books on various subjects, and also information about books on agriculture, home economics and related subjects.

LOCAL COMMUNITY ORGANIZATION. — Work under this project is temporarily suspended, leave of absence having been granted to the project leader to do some special work with the National Red Cross.

EXTENSION WORK IN AGRICULTURAL ECONOMICS. — Work in this field has been developing along six lines all connected with commercial agriculture, emphasizing the production of value or money returns rather than volume of agricultural products. Much of this work is conducted in direct co-operation with the United States Department of Agriculture.

(a) *Rural Credit.* — Sources and means of providing credit for buying or financing farms, purchasing supplies or storing and distributing farm crops.

(b) Better methods of marketing, grading and distributing farm crops.

(c) Assistance in organizing co-operative buying and selling associations. Helping to establish producers' city and country milk plants and co-operative tobacco packing plants.

(d) Assistance in establishing farmers' markets, both wholesale and retail, in cities, to furnish an outlet for perishable local produce and to provide a better market for consumers.

(e) *Direct Marketing.* — The college was the first agency to bring about direct connection between farmers and industrial plants for trading in potatoes, onions, etc., from farm to consumer.

(f) *Market News Survey.* — In co-operation with the farm bureaus and United States Bureau of Markets, a plan has been perfected whereby a daily market report of wholesale and retail prices of local produce is being furnished by the farm bureaus to a number of daily papers. These reports, made in retail units, have been very helpful both to producers and to city consumers.

FOOD PRESERVATION. — On account of the demands for instruction in food preservation, particularly preservation of fruits and vegetables, much attention was given to this work during the year, the work being carried on chiefly through training local leaders how to handle the work. Special attention is given to the manufacture of fruit by-products, to home and farm storage and to the operation of preservation kitchens. The project is carried

out through demonstrations, extension schools, farm visits and correspondence.

FARM BUREAU WORK. — Co-operative extension work is carried on in counties by means of farm bureaus. Agents in agriculture, homemaking and junior work are co-operatively employed by the Massachusetts Agricultural College, the United States Department of Agriculture and the county. The residents of the county are consulted in community groups as to the work which is to be done, and then all assistance which is possible to be secured from the United States Department of Agriculture, the college and the county brought in to successfully complete the work planned. The work receives its financial support from public funds which are secured from the above co-operating parties and the county commissioners. Private funds which are in the form of memberships and contributions are also received. The administration of the work in each county is vested in a board of ten trustees who are appointed by the county commissioners, co-operating with representatives of the Extension Service at the College.

ADVISORY WORK WITH INSTITUTIONS AND INDIVIDUALS. — Special effort is made to comply with as many of the requests of the State institutions and individuals who ask for advice on farm problems as possible. The force of instructors available for this work is at present insufficient to take care of all the demands. Special trips, including visits to a number of the various State institutions, are occasionally made by a group of specialists.

PUBLICATIONS OF THE EXTENSION SERVICE. — In addition to the regular circulars and bulletins which announce the various short courses and lines of work mentioned, publications giving timely information on agricultural subjects are issued. Large numbers of helpful circulars and bulletins are annually distributed. A series of bulletins especially for the farm woman is one feature of this work. Reports of the work of the Extension Service, farm account blanks, boys' and girls' club circulars, lists of books, and so forth, may be had upon request.

CO-OPERATION WITH OTHER ORGANIZATIONS. — The aim of the Extension Service is to co-operate with existing organizations so far as possible. It is therefore glad to work with local organizations, and welcomes suggestions from town officers, local granges, farmers' clubs, women's clubs, Y. M. C. A.'s, Y. W. C. A.'s, boards of trade, village improvement societies, teachers, clergymen, librarians and others interested in agriculture and country life, as to the needs and methods best adapted to the meeting of these needs.

INFORMATION BY CORRESPONDENCE. — Besides the activities mentioned, hundreds are helped through personal visits to farms, and still larger numbers through letters of inquiry, which always receive the most careful attention from every department of the institution.

Pamphlets and bulletins are sent free to all who apply for them, and any who desire such help as has been mentioned should address the Director of the Extension Service, Massachusetts Agricultural College, Amherst, Mass.

GENERAL INFORMATION

GENERAL INFORMATION.

A. FINANCIAL AND ADMINISTRATIVE.

Student Expenses.

TUITION.¹ — Tuition is free to residents of Massachusetts. Students who are not residents of Massachusetts are charged a tuition fee of \$60 a year. The tuition charged persons not citizens of the United States is \$120 a year. Students entering from Massachusetts are required to file with the president a statement signed by either town or city clerk stating that the applicant's father is a legal resident of Massachusetts; a similar statement is required of those entering from other States.

All students entering the college for the first time as undergraduates or unclassified students are charged a matriculation fee of \$5, which in event of a student leaving the institution shall, if all bills due the college are paid, be remitted, or which shall upon graduation be considered as payment for the diploma.

DORMITORIES AND BOARD. — The college has dormitory accommodations for about 62 students. The rooms in the dormitories are occupied by the upper classmen, hence new students find it necessary to room in private houses. The rooms in the college dormitories are unfurnished; for the most part they are arranged in suites of three, — one study room and two bedrooms. These rooms are heated by steam and lighted by electricity; they are cared for by students occupying them. The dormitory rent for each person varies from \$39 to \$66 a year. The rent for furnished rooms in private houses ranges from \$1 to \$3 a week for each occupant. Correspondence in regard to rooms should be addressed to the dean of the college.

Board may be obtained at the college dining hall. At present, the price of board there is about \$6.50 a week.

Expenses.

The necessary college expenses are estimated as follows: —

Tuition: citizens of Massachusetts, free; other citizens of the United States, \$60 a year; foreigners, \$120 a year.

	Low.	High.
Matriculation fee, first year, ...	\$5 00	\$5 00
Room in college dormitories or in private houses, ...	39 00	110 00
Board, \$6.50 per week, ...	234 00	234 00
Laundry, 50 to 85 cents a week, ...	18 00	30 00
Laboratory fees, ...	5 00	20 00
Books, stationery and miscellaneous items, ...	24 00	51 00
	\$325 00	\$450 00

¹ This statement applies to those registering as regular, two-year or unclassified students.

OTHER EXPENSES.—Prospective students should understand that the above estimates cover expenses which may be called strictly college expenses, and that there are other financial obligations voluntarily placed upon students which they should expect to meet. Chief among these are class assessments and taxes levied for maintenance of various organizations, such as the Social Union, Athletic Association, weekly publications, etc. Such expenses vary from \$15 to \$30 a year. Additional financial responsibility is also assumed by students joining a fraternity or entering into other social activities of the college. Students rooming in college dormitories are obliged to equip their own rooms with furniture. The college assumes no responsibility in regard to the safe keeping of student property either during the college term or vacations, except under such special arrangement as may be made with the treasurer. Besides the amount necessary for clothes and traveling, the economical student will probably spend between \$325 and \$450 per year.

INITIAL CHARGES.

At the opening of the college year, before students are registered in their classes, the following charges are payable at the treasurer's office:—

	Freshmen.	Sophomores.	Juniors and Seniors.
Matriculation fee, ...	\$5 00	—	—
Board (if at college dining hall) four weeks in advance,	26 00	\$26 00	\$26 00
Assessment for support of Social Union, ...	1 50	1 50	1 50
Laboratory fees, ...	5 00	5 00	2 00-10 00
Room rent (if in college dormitory), ...	—	—	12 00-20 00
Student tax for support of athletics, ¹	10 00	10 00	10 00
Student tax for support of nonathletic activities, ¹ .	2 50	2 50	2 50

¹ While this is not essentially a college charge, the treasurer of the college acts as collector for the student activity, and all students are expected to make the payment as indicated. The subscription price of the "Collegian" is fixed by the managers; the amount of athletic tax by vote of the student body.

LABORATORY FEES.

The principles observed in establishing laboratory fees are the requirement that students pay for those materials actually used which cannot be supplied by the individual, and that the laboratory fees include a charge sufficient to guard against wanton waste and breakage. Fees may be established for any course without previous announcement. At present, the fees charged are as follows:—

Agronomy:—	Per Term.
Course 27, 3, ...	\$1 50
Course 50, 1, ...	2 00
Course 51, 3, ...	2 00
Course 75, 1, ...	1 50
Course 76, 3, ...	1 50
Course 77, 2, ...	2 00
Course 78, 3, ...	2 00

[illegible]

Mathematics and engineering:—	Per Term.
Course 27, 3,	\$2 00
Course 78, 3,	2 00
Microbiology:—	
Course 50, 1, 2 and 3,	5 00
Course 51, 2 and 3,	5 00
Course 52, 3,	5 00
Course 75, 2,	5 00
Course 76, 3,	5 00
Course 80, 2,	5 00
Course 81, 1,	5 00
Course 82, 1,	5 00
Course 83, 1,	5 00
Physics:—	
Course 27, 3,	3 00
Course 50, 1,	3 00
Course 51, 2,	3 00
Course 52, 3,	3 00
Veterinary science:—	
Course 78, 1,	2 00
Course 79, 1,	2 00
Course 80, 3,	2 00
Course 85, 1,	2 00
Course 86, 2,	2 00
Course 87, 3,	2 00
Zoölogy and geology:—	
Course 25, 1,	3 00
Course Zoölogy 27, 3,	3 00
Course 50, 1,	3 00
Course 51, 2,	4 00
Course 52, 3,	4 00
Course 53, 1,	4 00
Course 54, 2,	3 00
Course 55, 3,	3 00
Course 58, .	2 00
Course 75, 1,	3 00
Course 76, 2,	3 00
Course 77, 3,	3 00
Course 78, .	2 00
Course 79, .	2 00
Rural journalism:—	
Course 53, 1,	2 00
Course 54, 2,	2 00
Course 55, 3,	2 00
Course 77, 1,	2 00
Course 78, 2,	2 00
Course 79, 3,	2 00
Course 80, 1,	2 00
Course 81, 2,	2 00
Course 82, 3,	2 00
Music (each course),	3 00

Rooms.

Students are expected, as far as possible, to occupy rooms in the college dormitories. Students who do not live in the college dormitories must secure rooms approved by the college. The assignment of rooms, and the general supervision of the housing of students, is in charge of the dean. The in-

spection of student quarters is in charge of the commandant. At the end of each college year all unoccupied rooms will be thrown open for selection, and will be assigned to students according to classes. Freshmen will be assigned rooms according to the date of application.

Women students are expected to occupy rooms in the college dormitory and such houses or apartments as the college may provide. No woman student will be allowed to room in a private house without a special written permission from the dean.

Student Aid.

SELF HELP. — Many students are obliged to find work of some sort to earn their way through college. A few men have met their entire expenses in this manner, many more have paid a large part of their expenses, and many have earned a small proportion of the cost of their college education; but the college recommends that no new student enter without having at least \$150 and preferably \$250 with which to pay his way until he can establish himself in some regular work. The college does not encourage students to enter without money in the expectation of earning their way entirely. The ordinary student will find it better either to work and accumulate money before coming to college, or to take more than four years in completing his college course, or, instead, to borrow money sufficient to carry him through. No student should undertake work that interferes with his studies, and students should understand that, owing to the large number of applications for employment, no one man can receive a large amount of work at the college. A number of students find opportunities for earning money without depending upon the college to furnish them with work.

So far as possible needy students will be employed in some department of the college. The divisions of agriculture and horticulture usually afford the most work, although there are several permanent janitorships available for students, and twenty or more students are employed at the dining hall.

Application for student labor should be made directly to Kenyon L. Butterfield, president of the college. Applicants are required to present statements from parent or guardian and from a public official or other responsible person of the town or city in which they reside, explaining the necessity of the applicant's need of assistance. Students whose deportment or class work is not satisfactory are not likely to be continued in student labor. The most desirable and responsible positions are naturally assigned to those needy students who have been in the institution longest and who have demonstrated their need and ability. Students, therefore, may find it rather difficult to obtain all the work they desire during their freshman year; as a matter of fact, however, any student who is capable of doing a variety of things, and who is a competent workman, usually finds little difficulty in obtaining all the work that he can do from the outset.

SPECIAL NOTICE TO NEEDY STUDENTS. — In the last few years the demand for paid labor on the part of new students has far exceeded the amount of employment that the college can offer. The college cannot promise work to any student, particularly to freshmen; it accordingly urges prospective students who are dependent entirely upon their own efforts not to undertake the course before they have earned enough money to carry them through, or nearly through, the first year.

Student Accounts.

The following rules are enforced concerning student accounts: —

No student will be allowed to graduate until all bills due the institution from him are paid.

College charges, such as room rent, laboratory fees and tuition, must be paid in advance, at the beginning of each term. This rule is strictly adhered to, and no student will be allowed to complete his registration until such payments are made.

Every student boarding at Draper Hall is required to pay at the beginning of each term at least one month's board in advance; and no student will be allowed to continue to board at Draper Hall if at any time during the term he is more than one week in arrears in his payment for board.

All money due for student labor shall at the discretion of the treasurer of the college be applied on account toward any bills that a student may owe to the institution.

Student Relations.

The customary high standard of college men in honor, manliness, self-respect and consideration for the rights of others constitutes the standards of student deportment.

Any student known to be guilty of dishonest conduct or practice must be reported by the instructor to the president for discipline.

The privileges of the college may be withdrawn from any student at any time, if such action is deemed advisable.

It should be understood that the college, acting through its president or any administrative officer designated by him, distinctly reserves the right not only to suspend or dismiss students, but also to name conditions under which students may remain in the institution. For example, if a student is not doing creditable work he may not only be disciplined but he may also be required to meet certain prescribed conditions in respect to his studies, even though under the foregoing rules his status as a student be not affected. The same provision applies equally to the matter of absences ("cuts"). According to the rules a student is allowed a certain percentage of absences from class and other exercises. This permission, which implies a privilege and not a right, may be withdrawn at any time for any cause.

Similarly, also, it applies to participation in student activities. Though this will ordinarily be governed by the rules as already laid down, yet, if in the judgment of the college authorities a student is neglecting his work on account of these activities, the privilege of participating in them may be withdrawn for such time as is considered necessary. Moreover, it may be withdrawn as a punishment for misconduct. Prospective students or their parents may, upon application, obtain a copy of the faculty rules governing student relations to the college.

Infirmary.

The college maintains an infirmary for the care of sick or injured students. The buildings now available for this purpose are quite inadequate for the needs of the institution, and it is hoped that in the near future other buildings of this kind may be erected and the general equipment somewhat amplified. At

present two small buildings, built especially for hospital purposes, are used for the infirmary.

The following statement outlines the plan followed in the management of the infirmary with respect to students:—

MANAGEMENT OF THE INFIRMARY.

Supervision.

1. The infirmary is under the *general supervision* of Prof. Charles E. Marshall who is designated as Supervisor of the Infirmary. Miss Elizabeth Olmsted, the resident nurse, is in *immediate* charge of the infirmary.

Use of Infirmary.

2. Students are urged to go to the infirmary at any time that they are in need of the services rendered by the resident nurse or by a town physician. Inasmuch as the physical director gives special attention to all student diseases, it is to be expected that the majority of the students will go to the infirmary at his suggestion. This understanding, however, should in no way deter students from going to the infirmary voluntarily at any time.

General Health.

3. Students are urged to consult the physical director or the resident nurse immediately when signs of physical disorder appear. Severe attacks of cold or other forms of illness can usually be avoided if treatment is administered in the incipient stage. The purpose of the infirmary is to help maintain the general good health of the students, as well as to furnish a suitable place for professional attention in cases of severe illness or accident.

General Fee.

4. The infirmary fee will be at the rate of \$1.50 a day, and will be charged when one or more meals are obtained at the infirmary, or when the student remains at the infirmary for one or more nights. A nominal charge will be made to out patients for miscellaneous treatment of a minor character.

Additional Expenses.

5. In addition to the fee charged, as specified in paragraph 4, the following additional expenses will be charged to the patient:—

(a) *Nurses.*—In case a special nurse is required for the proper care of an individual, the services and board of this nurse will be paid by the patient. Such a nurse will be under the general supervision of the resident nurse.

(b) *Professional Service.*—If a student requires medical attention by a physician, he will be required to select his physician and become responsible for fees charged by the physician.

(c) *Supplies.*—Special medical supplies prescribed by a physician or nurse will be charged to the patient.

(d) *Laundry.*—Expense for personal laundry incurred by students while in the infirmary will be charged to the individual student.

B. COLLEGE ACTIVITIES.

General Exercises.

Chapel exercises are held two mornings each week. On Wednesday an afternoon assembly is held, to which some prominent layman or professional man is invited to speak. The object of these assemblies is to bring to the students discussions of topics of present-day interest. A special chapel service on Sunday is usually held during the winter months. Students are required to attend these general exercises, although the president is authorized to excuse from chapel any student who may object to attendance thereon because of his religious scruples, provided his request for excuse therefrom is endorsed by his parent or guardian.

Student Activities.

A large number of student organizations furnish opportunity to students for work and leadership.

The Massachusetts Agricultural College Social Union was established about ten years ago. All students become members of the union by paying a small fee. The union is designed to become the center of student interests. In North College it has a trophy room and a large lounging room for music, reading and study; in the basement of this building there is also a game room for pool and billiards. In the fall and winter months the union gives a series of entertainments, free to students and faculty.

The College Senate is composed of representatives of the junior and senior classes. This body serves as a general director of undergraduate conduct, and represents before the faculty the interests of the student body.

The Young Men's Christian Association is active both socially and religiously. A Catholic club has also been organized.

The musical organizations include an orchestra, a mandolin club and a glee club. These furnish music for college meetings, and occasionally give concerts at the college and at other places. A military band is maintained as part of the cadet corps.

A dramatic club has been organized, and each year presents a play.

The Public Speaking Council represents the students' interest in debate and oratory.

The Athletic Association represents in the college the interests of football, baseball, track, hockey and basket ball.

A rifle club has been organized for a few years. Teams representing this club have repeatedly won the intercollegiate championship of the country, both in indoor and outdoor contests.

The college publications are the "Massachusetts Collegian" published weekly by the student body, and the "Index," published annually by the members of the junior class.

The Stockbridge Club is an organization of students especially interested in practical agriculture and horticulture. Regular meetings are addressed by outside speakers, and members present papers and engage in discussions.

Clubs also exist in the Departments of French, Entomology, Floriculture, Landscape Gardening, Zoölogy and Agricultural Economics.

There has recently been organized a Collegiate Country Life Club, the membership of which is composed of faculty and students who are particularly interested in the study of country life problems.

A nonathletics student activities board, composed of alumni, faculty and students, has charge of the finances, schedules, etc., of the musical clubs, dramatic club and student publications.

C. ACADEMIC AND DEPARTMENTAL.

Degrees.

Those who complete a four-year course receive the degree of bachelor of science. The fee for graduation from the college is \$5.

Graduate students who complete the assigned courses will receive the degree of master of science upon the payment of a fee of \$10. Credit may sometimes be allowed towards this degree for teaching or other advanced work done in some department of the college.

Graduate students who complete the required three-year course of study, and present a satisfactory thesis, will be granted the degree of doctor of philosophy.

Those to whom degrees are awarded must present themselves in person at commencement to receive them. No honorary degrees are conferred.

The honorary fraternity of Phi Kappa Phi has a chapter at the agricultural college. Students are elected to membership to this fraternity on the basis of scholarship. Elections are made from the highest tenth of the senior class who have attained an average grade of at least 85 per cent during their college course.

Prizes.

Prizes are given annually in several departments for excellence in study or for other special achievement. Prizes offered in 1914 were:—

AGRICULTURE.—The Grinnell prizes, given by Hon. William Claflin of Boston in honor of George B. Grinnell, Esq., of New York, for excellence in theoretical and practical agriculture. Three prizes, \$25, \$15, \$10. The contest is open to those senior students whose record on the registrar's books shows an average standing of 80 or above for the technical work taken in the Divisions of Agriculture and Horticulture during the junior and senior years. Applicants should register with the head of the Division of Agriculture before noon, June 2, 1918.

BOTANY.—The Hills prizes, given by Henry F. Hills of Amherst, amount to \$35 annually. Competition is open to members of the senior, junior and sophomore classes as follows: for the best herbarium, \$20; for the second best herbarium, \$15. No collection deemed unworthy of a prize will be considered.

PUBLIC SPEAKING.—The Burnham prizes are awarded as follows: to the students delivering the best and second best declamations in the Burnham contest, \$15 and \$10, respectively. The preliminary contests in declamation are open, under certain restrictions, to freshmen and sophomores.

The Flint prizes are awarded as follows: to the students delivering the best and second best orations in the Flint contest, a gold medal and \$20 and \$15, respectively. The preliminary contests in oratory are open, under certain restrictions, to all regular students.

The prizes in debate are awarded as follows: to each of the three students ranking highest in the annual debating contest, a gold medal and \$15. The preliminary contests in debate are open, under certain restrictions, to all regular students.

Awards and Prizes.

GRINNELL PRIZES. — The Grinnell prizes, given by the Hon. William Claflin of Boston in honor of George B. Grinnell, Esq., of New York, to those members of the senior class who pass the best, second best and third best examinations, oral and written, in theoretical and practical agriculture, were awarded as follows: —

First prize, \$25, awarded to Mr. George Edwin Erickson.

Second prize, \$15, awarded to Mr. Raymond Thurston Parkhurst.

Third prize, \$10, awarded to Mr. Arthur Lincoln Chandler.

PUBLIC SPEAKING. — The Burnham prizes were awarded to the students delivering the best and second best declamations, as follows: —

First prize, \$15, awarded to Mr. Willis Tanner, 1922.

Second prize, \$10, awarded to Mr. Francis Fletcher, 1921.

The Flint prizes were awarded to the students delivering the best and second best orations, as follows: —

First prize, medal and \$20, awarded to Mr. Henry J. Burt, 1919.

Second prize, \$15, awarded to Mr. John A. Crawford, 1920.

HILLS PRIZE. — A second prize of \$15 for the best herbarium was awarded to Mr. Emil F. Guba, 1919.

MILITARY HONORS. — The following-named Cadet officers have been granted the military diploma and have been reported to the Adjutant-General of the United States Army and to the Adjutant-General of the Commonwealth of Massachusetts as being efficient in military science and tactics and graduating with highest honors: —

Cadet Maj. Harold Edwin Spaulding.

Cadet Capt. Vincent DePaul Callanan.

Cadet Capt. Verne Allen Fogg.

Cadet Capt. William Joseph Sweeney.

Cadet 1st Lieut. Paul Faxon.

Cadet 2d Lieut. Victor Abel Dickinson.

STATE TEACHER'S CERTIFICATE. — The following persons, having fulfilled the requirements for a Massachusetts State teacher's certificate, have been recommended for the same to the State Department of Education by the acting dean and the Department of Agricultural Education: Miss Olive E. Carroll, Benjamin E. Hodgson and Raymond R. Willoughby.

DEGREES CONFERRED AND
ROLL OF STUDENTS

DEGREES CONFERRED — 1919.

MASTER OF SCIENCE (M.Sc.).

Jones, Linus Hale, Milford, Mass., Massachusetts Agricultural College, B.Sc.

BACHELOR OF SCIENCE (B.Sc.).

Bagg, Quincy Austin, ...	South Hadley.
Blanchard, Carlton Douglas, ...	Uxbridge.
Bond, Herbert Richard, ...	Needham.
Bowen, Arthur Newton, ...	Providence, R. I.
Brigham, Sylvia Bowen, ...	Newtonville.
Burt, Henry John, ...	Arlington.
Callanan, Vincent DePaul, ...	Malden.
Carpenter, Hall Bryant, ...	Somerville.
Carroll, Olive Evangeline, ...	Dorchester.
Chandler, Arthur Lincoln, ...	Leominster.
Chisholm, Robert Dudley, ...	Melrose Highlands.
Collins, Robert Burleigh, ...	Rockland.
Cosby, Alfred Francis, ...	Westfield.
Davis, Albert Noah, ...	Somers, Conn.
Dickinson, Victor Abel, ...	Amherst.
Erhard, Bena Gertrude, ...	East Milton.
Erickson, George Edwin, ...	Brockton.
Erickson, Gunnar Emmanuel, ...	West Lynn.
Evans, Myrton Files, ...	West Somerville.
Faber, Edward Stuart, ...	Plainfield, N. J.
Faneuf, Ambrose Clement, ...	West Warren.
Faxon, Paul, ...	Wellesley Hills.
Ferriss, Samuel Boynton, ...	New Milford, Conn.
Field, Wilbert Daniel, ...	Winter Hill.
Fogg, Verne Allen, ...	Danvers.
French, Willard Kyte, ...	Worcester.
Garde, Earl Augustus, ...	Lynn.
Garvey, Mary Ellen Monica, ...	Amherst.
Gasser, Thomas Jefferson, ...	Uxbridge.
Guba, Emil Frederick, ...	New Bedford.
Hance, Forrest Sansbury, ...	Paterson, N. J.
Harris, Ethel Lovett, ...	Beverly.
Hartwell, Richard Raymond, ...	Springfield.
Hastings, Louis Pease, ...	Springfield.
Hodgson, Benjamin Earl, ...	Methuen.
Howe, Ralph Thomas, ...	Melrose.
Huntoon, Douglas Henderson, ...	Norwood.
Jewell, Charles Henry, ...	Merrimac.
Johnson, Sidney Clarence, ...	Gloucester.
Knowlton, Priscilla, ...	Roxbury.
Liebman, Anna, ...	Dorchester.
Mather, William, ...	Amherst.
Mattoon, Charles Gordon, ...	Pittsfield.
McCarthy, Arthur Martin, ...	Munson.
McKee, William Henry, ...	Pittsfield.
Parke, Robert Warren, ...	Winchendon.

Parkhurst, Raymond Thurston,	Fitchburg.
Patch, Lawrence Henry,	Wenham.
Peck, George Newberry,	Granville.
Peirson, Henry Byron,	New Bedford.
Phipps, Clarence Ritchie,	Dorchester.
Pulley, Marion Gertrude,	Melrose.
Rea, Julian Stuart,	East Weymouth.
Roberts, Oliver Cousins,	Arlington.
Sibley, Helen Aramintha,	Wollaston.
Smith, Wendell Frederick,	Pittsfield.
Stafford, Irving Boynton,	Fall River.
Stevens, Chester Dillingham,	Reading.
Stockwell, Ervin Sidney, Jr.,	Sharon.
Strack, Edward,	Framingham.
Sutherland, Ralph,	Cambridge.
Sweeney, William Joseph,	Dorchester.
Thomas, Frank DesAutel,	Milford.
Thompson, Wells Nash,	Adams.
Vickers, John,	Amherst.
Wells, Marion Nichols,	Springfield.
White, Edward Asa,	Providence, R. I.
Willoughby, Raymond Royce,	New Britain, Conn.
Wood, Oliver Wiswall,	Arlington.
Woodard, Chester Smith,	Leverett.
Yesair, John,	Newburyport.

BACHELOR OF SCIENCE, HONORIS CAUSA.

- Hamburger, Amos Francis, Class of 1908, died of disease at Camp Meade, Oct. 6, 1918.
- Wood, Lieut. Alton Palmer, Class of 1911, died of wounds in France, May 4, 1918.
- Hutchison, Robert Baker, Class of 1913, killed in action in France, Sept. 7, 1918.
- Chapon, Robert Henri, Class of 1914, killed in action in France, Dec. 30, 1914.
- Koplovitz, Samuel, Class of 1915, killed in action at Verdun, Oct. 24, 1918.
- Chamberlin, Raymond, Class of 1916, killed in action in France, Sept. 26, 1918.
- Farwell, Lieut. Alfred Austin, Class of 1917, died of disease at Camp Merritt, Dec. 29, 1918.
- Harris, Warren Timothy, Class of 1917, died of disease at Fort Slocum, Oct. 9, 1918.
- Foster, Capt. Hamilton Knight, Class of 1918, killed in action in the Argonne, France, Oct. 4, 1918.
- Irvine, Robert Patterson, Class of 1918, died of disease at Camp Logan, Jan. 16, 1919.
- Jones, Forrest Dean, Class of 1918, killed in airplane accident at Kelley Field, April 16, 1918.
- Petit, Arthur Victor, Class of 1918, died of disease in France, Jan. 9, 1919.
- Woodworth, Lieut. Brooks, Class of 1918, died of disease at Camp Lee, Oct. 20, 1918.
- Callanan, Lieut. John Edward, Class of 1919, died of disease at Dorchester, Dec. 24, 1918.
- Cooley, Edwin Prince, Class of 1919, killed in action at Bazoches, France, Aug. 26, 1918.
- Day, Elston Almond, Class of 1919, died of disease at Camp Devens, Sept. 26, 1918.
- Desmond, Lieut. Thomas Whitty, Class of 1919, killed in action in France, May 27, 1918.
- Moore, John Raymond, Class of 1919, died of wounds in France, Oct. 16, 1918.
- Sexton, Lieut. Ernest Francis, Class of 1919, killed in action at Premont, France, June 4, 1918.
- Woodside, Wilfred Livingstone, Class of 1919, killed in airplane accident at Caruthers Field, Oct. 14, 1918.
- Gay, Lawrence Washburn, Class of 1920, died of wounds in France, Oct. 30, 1918.
- Roberts, Lieut. Ivan Andrew, Class of 1920, died from wounds in German hospital, Oct. 1, 1918.
- Hathaway, Lieut. Warren Sidney, Class of 1921, died of wounds in France in November, 1918.
- MacCormack, Lieut. Ralph Roby, Class of 1921, killed in airplane accident at Pensacola, Fla., Feb. 7, 1919.
- Kile, Trueman Eugene, Class of 1921, died of disease at Providence, R. I., Dec. 6, 1918.

REGISTRATION, 1919-20.

GRADUATE STUDENTS.

Albrecht, Daniel A., ...	Champaign, Ill.
A.B., University of Illinois.	
B.Sc., University of Illinois.	
Avery, Roy Crowdy, ...	New York City.
B.Sc., Connecticut Agricultural College.	
Bourne, Arthur I., ...	Amherst.
A.B., Dartmouth College.	
Fagan, Frank Nelson, ...	State College, Pa.
B.Sc., Ohio State University.	
Faneuf, Ambrose C., ...	West Warren.
B.Sc., Massachusetts Agricultural College.	
Folsom, Josiah C., ...	South Hadley.
B.Sc., Massachusetts Agricultural College.	
Gagnon, Aimé, ...	Laprairie, P. Q., Can.
B.A., Laval University.	
Garvey, Mary E., ...	Amherst.
B.Sc., Massachusetts Agricultural College.	
Godbout, Adelard, ...	Ste. Anne de la Pocatière, P. Q., Can.
B.A., B.S.A., École d'Agriculture de Ste. Anne de la Pocatière.	
Gordon, Thomas B., ...	Lexington, Ky.
B.S.Agr., University of Kentucky.	
Greenwood, Arthur M., ...	Ashburnham.
A.B., Brown University.	
M.D., Harvard Medical School.	
Harrington, William Chauncey, ...	Amherst.
A.B., Harvard College.	
Harris, Roy Dudley, ...	Middlebury, Vt.
B.Sc., Middlebury College.	
Helder, Arthur H., ...	Kansas City, Mo.
B.Sc., Kansas State Agricultural College.	
M.Sc., Kansas State Agricultural College.	
Hood, Egerton G., ...	Amherst.
B.S.A., University of Toronto.	
Jennings, Marjorie Squire (Mrs. John F.), ...	Longmeadow.
A.B., Smith College.	
Jewell, Charles Henry, ...	Merrimac.
B.Sc., Massachusetts Agricultural College.	
Julian, Arthur N., ...	Amherst.
A.B., Northwestern University.	
Lieber, Conrad H., ...	Jamaica Plain.
B.Sc., Massachusetts Agricultural College.	
Mallorey, Alfred S., ...	Lynn.
B.Sc., Massachusetts Agricultural College.	
Middleton, Joseph Altman, ...	Clemson College, S. C.
B.Sc., Clemson College.	
Morgan, Ezra Leon, ...	Amherst.
A.B., McKendree College.	
M.A., University of Wisconsin.	
Morse, Fred W., Jr., ...	Amherst.
B.Sc., Dartmouth College.	

Mutkekar, Satwaji G., ...	Belgaum, India.
B.Agr., Poona Agricultural College.	
M.Sc., Massachusetts Agricultural College.	
Pauley, William C., ...	Lafayette, Ind.
B.S. in Agr., Purdue University.	
Perrins, William Arthur, Jr., ...	Jamaica Plain.
A.B., Harvard College.	
Prince, Arthur Leslie, ...	Webster.
A.B., Clark College.	
Purington, James A., ...	Hopkinton, N. H.
B.Sc., New Hampshire State College.	
Serex, Paul, Jr., ...	Amherst.
B.Sc., Massachusetts Agricultural College.	
M.Sc., Massachusetts Agricultural College.	
Spencer, Leland, ...	Elmira, N. Y.
B.Sc., Cornell University.	
Sturgis, Russell D., ...	Wilmington, Del.
B.Sc., Delaware College.	
Whitaker, Leslie Clinton, ...	Sacramento, Cal.
B.Sc., Oregon Agricultural College.	
Wood, Oliver W., ...	Arlington.
B.Sc., Massachusetts Agricultural College.	

CLASS OF 1920 (SENIORS).

Apsey, George Wills, Jr., ...	Winchester, ...	Alpha Sigma Phi.
Babbitt, George King, ¹	Bridgewater, Conn., ...	Alpha Sigma Phi.
Bacon, Milo Roderick, ...	Leominster, ...	Sigma Phi Epsilon.
Baker, Henry Raymond, ¹	Amherst, ...	West Street.
Baker, William Alphonso, ¹	Melrose, ...	Lambda Chi Alpha.
Ball, Harry Abraham, ¹	Bridgewater, ...	Commons Club.
Batchelder, Stewart Putnam, ...	North Reading, ...	Q. T. V.
Beauregard, Winfield Scott, ...	Framingham, ...	Sigma Phi Epsilon.
Belcher, Daniel Webster, ...	North Easton, ...	Stockbridge Hall.
Berman, Harry, ...	Holyoke, ...	7 South College.
Binks, Frank Joseph, ...	Maynard, ...	Alpha Gamma Rho.
Boardman, Charles Meade, ...	Amherst, ...	Q. T. V.
Boyce, Alan Freeman, ...	Melrose, ...	83 Pleasant Street.
Brown, Roy Robertson, ...	Allston, ...	Theta Chi.
Burns, Allan Melville, Jr., ...	Taunton, ...	Theta Chi.
Burton, Lee Williams, ...	Plainville, ...	South College.
Campbell, George Murray, ¹	Baltimore, Md., ...	Phi Sigma Kappa.
Card, Ralph Hunter, ...	Somerville, ...	Commons Club.
Carleton, John Foxcroft, ...	East Sandwich, ...	Sigma Phi Epsilon.
Chase, Malcolm Willis, ¹	Amesbury, ...	Draper Hall.
Clapp, Augustus Warren, ...	East Braintree, ...	Lambda Chi Alpha.
Claridge, Fred William, ...	Milford, ...	Theta Chi.
Clough, Alfred Arnold, ...	Wollaston, ...	Theta Chi.
Cole, Frederick Eugene, Jr., ...	South Portland, Me., ...	15 South College.
Crafts, Gordon Burnham, ...	Manchester, ...	Q. T. V.
Crawford, John Alexander, ...	Allston, ...	Alpha Gamma Rho.
Crowe, Charles, ¹	Norwich, Conn., ...	Kappa Sigma.
Daggett, Clinton Jones, ...	Albany, N. Y., ...	Kappa Sigma.
Delahunt, John Kersey, ...	Boston, ...	Kappa Gamma Phi.
Derick, Glendon Robert, ...	Clinton, ...	North College.
Dewing, Warren Montague, ...	Kingston, ...	Kappa Sigma.
Doucette, Charles Felix, ...	Melrose, ...	Commons Club.
Dowd, William Lawrence, ¹	North Amherst, ...	North Amherst.
Dunn, Arthur Paul, ...	Malden, ...	Alpha Gamma Rho.
Earley, Marion Edith, ...	Redlands, Calif., ...	Draper Hall.
Emery, Herbert Martin, ...	Newburyport, ...	3 North College.
Fanuef, Leo Joseph, ¹	West Warren, ...	6 Nutting Avenue.

¹ Work incomplete.

Fellows, Harold Carter, . . .	Peabody, . . .	North College.
Frellick, Arthur Lester, ¹ . . .	Everett, . . .	13 Phillips Street.
Fuller, Camille Baldwin, ¹ . . .	Quincy, . . .	North College.
Gifford, Flavel Mayhew, . . .	West Tisbury, . . .	North College.
Glavin, William Francis, . . .	Wenham, . . .	Sigma Phi Epsilon.
Goodridge, George Lucien, ¹ . . .	Melrose, . . .	Lambda Chi Alpha.
Goodwin, William Irving, ¹ . . .	Bradford, . . .	13 South College.
Gordon, Frederick George, . . .	Plymouth, . . .	7 Phillips Street.
Graff, Leland Sprague, ¹ . . .	Newton Center, . . .	Q. T. V.
Graves, Carlisle Ferrin, . . .	Stamford, Conn., . . .	Alpha Sigma Phi.
Gray, Milton Berford, . . .	Woods Hole, . . .	Alpha Gamma Rho.
Grayson, Forrest, . . .	Milford, . . .	Alpha Sigma Phi.
Green, Lynn, . . .	Schenevus, N. Y., . . .	53 Lincoln Avenue.
Hamlin, Hazen Wolcott, . . .	North Amherst, . . .	North Amherst.
Harrington, Harold Leon, . . .	Lunenburg, . . .	Kappa Gamma Phi.
Harvey, Ebenezer Erskine, . . .	Washington, D. C., . . .	15 South College.
Hawley, Robert Dorman, . . .	Springfield, . . .	Phi Sigma Kappa.
Hill, John Farren, . . .	Egypt, . . .	Kappa Gamma Phi.
Holloway, Joann William, . . .	Taunton, . . .	Theta Chi.
Holmes, Robert Palmer, . . .	Agawam, . . .	Aggie Inn.
Horne, Robert Sanderson, . . .	Derry Village, N. H., . . .	Q. T. V.
Howard, Arthur Merchant, . . .	Pittsfield, . . .	84 Pleasant Street.
Howe, Albert Edward, ¹ . . .	Needham, . . .	8 South College.
Hurlburt, Ralph Walter, . . .	Ashley Falls, . . .	Sigma Phi Epsilon.
Jakeman, Brooks Franklin, . . .	Winchester, . . .	Lambda Chi Alpha.
Johnson, Lawrence Wilhelm, ¹ . . .	Avon, . . .	Alpha Sigma Phi.
Littlefield, John Edwin, . . .	West Lynn, . . .	11 North College.
Lothrop, Earle Daniel, . . .	West Bridgewater, . . .	Alpha Gamma Rho.
Luce, William Alan, . . .	West Boylston, . . .	Lambda Chi Alpha.
Lyons, Henry Egmont, . . .	Cambridge, . . .	East Experiment Station.
MacLeod, Guy Franklin, . . .	Lowell, . . .	Alpha Sigma Phi.
Maginnis, John Joseph, ¹ . . .	Lawrence, . . .	Alpha Sigma Phi.
Maples, James Comly, . . .	Port Chester, N. Y., . . .	Kappa Sigma.
Marshall, Max Skidmore, . . .	Amherst, . . .	44 Sunset Avenue.
Mather, Fred, . . .	Amherst, . . .	Veterinary Laboratory.
Meserve, Albert Wadsworth, . . .	Framingham, . . .	Kappa Gamma Phi.
Millard, Helen Stanley, ¹ . . .	Great Barrington, . . .	Draper Hall.
Mitchell, Theodore Bertis, . . .	Needham, . . .	13 South College.
Morse, Maurice, . . .	Dorchester, . . .	14 South College.
Moynihan, Patrick Joseph, . . .	Holyoke, . . .	Alpha Sigma Phi.
Oertel, August Leonard, . . .	South Hadley Falls, . . .	4 Chestnut Street.
Peckham, William Harold, . . .	Newport, R. I., . . .	Alpha Sigma Phi.
Perry, Errol Clinton, . . .	Acushnet, . . .	11 North College.
Pike, Chester Arthur, . . .	Springfield, . . .	Mathematics Building.
Pond, Allan Leon, . . .	Holliston, . . .	Kappa Sigma.
Prée, Karl Julius, . . .	Brookline, . . .	Theta Chi.
Quadland, Howard Preston, ¹ . . .	North Adams, . . .	Sigma Phi Epsilon.
Readio, Philip Adna, . . .	Florence, . . .	Alpha Gamma Rho.
Redding, George Kenneth, . . .	Melrose, . . .	Commons Club.
Roberts, Mark Anthony, . . .	Dorchester, . . .	25 Lincoln Avenue.
Robertson, William Fenton, ¹ . . .	Framingham, . . .	Kappa Gamma Phi.
Sampson, Fred Buckman, . . .	Fall River, . . .	18 Nutting Avenue.
Sanborn, Joseph Raymond, ¹ . . .	North Amherst, . . .	North Amherst.
Sanderson, Ralph Hemenway, . . .	Waltham, . . .	Kappa Gamma Phi.
Sargent, Walter Harriman, ² . . .	Malden, . . .	
Sawyer, Wesley Stevens, . . .	Boston, . . .	Alpha Gamma Rho.
Scott, Clifton William, . . .	Buckland, . . .	Alpha Gamma Rho.
Simmons, Lester Winslow, . . .	Dighton, . . .	Theta Chi.
Skinner, Everett Hamilton, ¹ . . .	West Upton, . . .	Kappa Sigma.
Smith, George Alfred, ¹ . . .	Whitinsville, . . .	Q. T. V.
Smith, Raymond Newton, ¹ . . .	Plainville, . . .	15 South College.

¹ Work incomplete.² Registered Feb. 27, 1919; left May 8, 1919.

Smith, Susan Almira, . . .	Great Barrington, . . .	Draper Hall.
Spaulding, Harold Edwin, ¹ . . .	Milford, . . .	Kappa Sigma.
Stedman, Ralph Shaw, . . .	Springfield, . . .	Phi Sigma Kappa.
Stowe, Raymond Timothy, . . .	Scitico, Conn., . . .	51 Amity Street.
Sullivan, Walter Mitchell, ¹ . . .	Lawrence, . . .	Alpha Sigma Phi.
Swift, Raymond Walter, ¹ . . .	North Amherst, . . .	North Amherst.
Taylor, Elliot Hubbard, . . .	Shelburne, . . .	Q. T. V.
Thayer, Weston Cushing, . . .	Hingham, . . .	Kappa Gamma Phi.
Urquhart, John Wardrop, . . .	East Walpole, . . .	Kappa Gamma Phi.
Williams, Allan Carruth, ¹ . . .	Rockland, . . .	11 North College.
Window, James Joseph, . . .	Springfield, . . .	17 Fearing Street.
Woodbury, Ray Willard, ¹ . . .	Newburyport, . . .	Cottage Street.
Wooding, Paul Bennett, ¹ . . .	Yalesville, Conn., . . .	French Hall.
Woodward, George Blossom, ¹ . . .	Albany, N. Y., . . .	Kappa Sigma.
Worthley, Harlan Noyes, . . .	Amherst, . . .	7 Phillips Street.
Wright, Stuart Eldridge, . . .	Raynham Center, . . .	Kappa Sigma.

CLASS OF 1921 (JUNIORS).

Alger, James Warren, ¹ . . .	Reading, . . .	Kappa Sigma.
Allen, Harold Kenneth, . . .	Belchertown, . . .	Belchertown.
Allen, Henry Vaughn, . . .	Arlington, . . .	Phi Sigma Kappa.
Andersen, Charles Henry, ¹ . . .	Medford, . . .	Theta Chi.
Armstrong, Philip Brownell, . . .	Rutherford, N. J., . . .	Phi Sigma Kappa.
Bailey, William, Jr., ¹ . . .	Williamstown, . . .	Commons Club.
Baker, Louis Eliot, . . .	Salem, . . .	16 South College.
Baker, Russell Dexter, ¹ . . .	Oxford, Me., . . .	17 Fearing Street.
Bögholt, Carl Miller, ¹ . . .	Newport, R. I., . . .	53 Lincoln Avenue.
Boynton, Raymond Woods, ¹ . . .	Framingham, . . .	53 Lincoln Avenue.
Brigham, John Dexter, ¹ . . .	Sutton, . . .	Lambda Chi Alpha.
Brown, Paul Wilfred, . . .	Fiskdale, . . .	Lambda Chi Alpha.
Bunker, Carroll Wooster, . . .	West Somerville, . . .	Q. T. V.
Calhoun, Saltean Frederick, . . .	Brookline, . . .	Kappa Gamma Phi.
Cameron, Viola Mary, ¹ . . .	Amherst, . . .	Draper Hall.
Cascio, Peter Joseph, ¹ . . .	Willimantic, Conn., . . .	Draper Hall.
Coombs, Roger Conklin, . . .	Peabody, . . .	Sigma Phi Epsilon.
Cooper, Lawrence Melville, ¹ . . .	Charlemont, . . .	Alpha Gamma Rho.
Davenport, Frank Semore, . . .	Dorchester, . . .	Alpha Sigma Phi.
Davidson, Donald Gordon, . . .	Amherst, . . .	10 Maple Avenue.
Davis, Orrin Chester, ¹ . . .	Belchertown, . . .	Alpha Gamma Rho.
Dean, Herman Nelson, ¹ . . .	Oakham, . . .	Q. T. V.
Douglass, Donald Churchill, ¹ . . .	Cambridge, . . .	Phi Sigma Kappa.
Dunbar, Charles Oliver, ¹ . . .	Westfield, . . .	84 Pleasant Street.
Edman, George William, ¹ . . .	Orange, . . .	Q. T. V.
Evers, Joseph Daniel, . . .	Malden, . . .	Draper Hall.
Fletcher, Francis Summers, ¹ . . .	East Lynn, . . .	Alpha Gamma Rho.
Fuller, Lorenzo, . . .	Lowell, . . .	Mathematics Building
Gaskill, Harland Everett, ¹ . . .	Hopedale, . . .	Alpha Sigma Phi.
Geer, Herbert Leroy, . . .	Three Rivers, . . .	Q. T. V.
Goff, Howard Mason, . . .	Cambridge, . . .	Phi Sigma Kappa.
Gould, Robert Meredith, . . .	Shelburne, . . .	Q. T. V.
Gray, Irving Emery, ¹ . . .	Woods Hole, . . .	Alpha Gamma Rho.
Hagar, Joseph Archibald, ¹ . . .	Newtonville, . . .	Kappa Sigma.
Haskins, Harold Arthur, . . .	North Amherst, . . .	North Amherst.
Haslam, Emerson Francis, ¹ . . .	Westwood, . . .	Theta Chi.
Haynes, Charles Francis, ¹ . . .	Canton, . . .	North College.
Howard, Frederic, . . .	Mansfield, . . .	Lambda Chi Alpha.
Howe, George Cole, . . .	Worcester, . . .	81 Pleasant Street.
Hunter, Harold Clayton, ¹ . . .	South Hadley Falls, . . .	6 Nutting Avenue.
Hurd, Davis Alden, ¹ . . .	Wellesley Hills, . . .	Alpha Gamma Rho.
Hurd, Gordon Killam, ¹ . . .	Millbury, . . .	Physics Laboratory.
Iorio, Carlo Antonio, . . .	Hartford, Conn., . . .	East Experiment Station.

¹ Work incomplete.

Jones, Robert Lambert, ¹	Attleboro,	Q. T. V.
Kendall, Charles Donald, ¹	Worcester,	Q. T. V.
Kimball, William Lincoln, ¹	Orange,	Phi Sigma Kappa.
King, Starr Margetts,	Pittsfield,	Kappa Sigma.
Kirkland, Lyle Lord,	Chester,	Kappa Gamma Phi.
Knight, Frank Edward, ¹	Brimfield,	South College.
Labrovitz, Edward Browdy, ¹	Amherst,	11 Amity Street.
Lambert, Richard Bowles,	Gleasondale,	Lambda Chi Alpha.
Leavitt, Ralph Goodwin, ¹	Melrose Highlands,	Theta Chi.
Leighton, Arthur Whiting,	Abington,	9 Fearing Street.
Lent, Donald Ashford,	Maynard,	Alpha Gamma Rho.
Lincoln, Newton Ewell,	Dorchester,	13½ Amity Street.
Lockwood, George Russell,	Waban,	Theta Chi.
Long, Albert Douglas, ¹	Amherst,	Sigma Phi Epsilon.
Mackintosh, Charles Gideon,	Peabody,	Phi Sigma Kappa.
Mallon, Charles Hugh,	East Braintree,	Phi Sigma Kappa.
Mansell, Elton Jessup, ¹	Cambridge,	Phi Sigma Kappa.
Martin, Laurence Paul, ¹	Malden,	Alpha Sigma Phi.
McCarthy, Justin Jeremiah, ¹	Arlington,	Phi Sigma Kappa.
McNulty, Raymond Henry, ¹	Amherst,	6 South East Street.
Mellen, Richard Adams, ¹	Cambridge,	Sigma Phi Epsilon.
Miller, William Henry,	Springfield,	Commons Club.
Newell, Philip Sanger,	West Newton,	Phi Sigma Kappa.
Newton, Edward Buckland, ¹	Holyoke,	Commons Club.
O'Hara, Joseph Ernest, ¹	Worcester,	8 Kellogg Avenue.
Palmer, Walter Isaiah, ¹	Amherst,	13 South Prospect Street.
Peck, Richard Charles, ¹	Shelburne,	West Experiment Station.
Poole, Harold Walter, ¹	Hudson,	Alpha Gamma Rho.
Pratt, Laurence Francis,	North Weymouth,	Q. T. V.
Preston, Everett Carroll, ¹	Dorchester,	Kappa Gamma Phi.
Quint, Isador Gabriel, ¹	Roxbury,	16 South College.
Readio, Roger Frank,	Florence,	Alpha Gamma Rho.
Reed, Morris,	Worcester,	56 Pleasant Street.
Rice, Henry Lawrence,	Somerville,	Kappa Sigma.
Richards, George Henry,	Springfield,	Phi Sigma Kappa.
Robinson, Philip Luther, ¹	New Bedford,	Alpha Gamma Rho.
Rosoff, Samuel Nathaniel, ¹	Springfield,	16 South College.
Russert, Marion Ruth, ¹	Roxbury,	Draper Hall.
Sampson, Howard Jenney, ¹	Fall River,	Theta Chi.
Sanford, Richard Herbert, ¹	Westfield,	Sigma Phi Epsilon.
Shaughnessy, Howard John,	Springfield,	17 Phillips Street.
Slate, George Lewis, ¹	Barnardston,	Alpha Gamma Rho.
Sloan, Kenneth Wilson, ¹	Amherst,	29 North Prospect Street.
Smith, Jonathan Harold,	Roslindale,	83 Pleasant Street.
Smith, Richard Watson, Jr., ¹	Sylacauga, Ala.,	116 Pleasant Street.
Snow, John Dow,	Arlington,	Phi Sigma Kappa.
Spencer, Orville Holland, ¹	West Haven, Conn.,	Phi Sigma Kappa.
Starkey, Robert Lyman, ¹	Fitchburg,	Phi Sigma Kappa.
Stevens, Ralph Shattuck, ¹	Arlington,	Theta Chi.
Stiles, Harry Stephen, ¹	Lynn,	Kappa Gamma Phi.
Tietz, Harrison Morton,	Richmond Hill, N. Y.,	37 Cottage Street.
Tillson, Reginald Drury,	Whitman,	21 Fearing Street.
Van Lennep, Emily Bird,	Great Barrington,	Draper Hall.
Waite, Richard Austin, ¹	Middlefield,	Alpha Gamma Rho.
Watkins, Tscharner Degraffenreidt, ¹	Midlothian, Va.,	41 Lincoln Avenue.
Webster, Milton Fuller, ¹	Malden,	Kappa Gamma Phi.
West, Guy Clifford,	Amesbury,	Kappa Gamma Phi.
Whittle, Clarence Parker, Jr., ¹	Weymouth,	Phi Sigma Kappa.
Wood, Clarence Milton,	West Somerville,	Lambda Chi Alpha.
Zercher, Frederick Kaupp, ¹	Huntington, W. Va.,	Q. T. V.

¹ Work incomplete.

CLASS OF 1922 (SOPHOMORES).

Acheson, Roger Melvin, . . .	New Bedford, . . .	Alpha Gamma Rho.
Andrews, John Hollis, ¹ . . .	Vineyard Haven, . . .	Commons Club.
Bainton, Hubert Judson, ¹ . . .	Hyde Park, . . .	Commons Club.
Baker, George Louis, . . .	Amherst, . . .	West Street.
Barnard, Kenneth Allen, . . .	Shelburne, . . .	Q. T. V.
Beckwith, Robert Henry, . . .	Wellesley Hills, . . .	Entomology Building.
Bent, Leslie Dana, . . .	Medfield, . . .	Lambda Chi Alpha.
Bigelow, George Samuel, ¹ . . .	Millville, N. J., . . .	116 Pleasant Street.
Blakely, Roger Wolcott, . . .	Medford, . . .	46 Pleasant Street.
Blanchard, Raymond Stanwood, ¹ . . .	Wollaston, . . .	7 Nutting Avenue.
Bowen, Willard Lee, Jr., ¹ . . .	Natick, . . .	Phi Sigma Kappa.
Bromley, Stanley Willard, . . .	Southbridge, . . .	75 Pleasant Street.
Buck, Charles Alfred, . . .	Mansfield, . . .	Alpha Gamma Rho.
Burnett, Paul Lapham, ¹ . . .	Leicester, . . .	Theta Chi.
Burnham, Edwin Graham, . . .	Springfield, . . .	Lambda Chi Alpha.
Carey, Edmund Thomas, . . .	Springfield, . . .	Kappa Gamma Phi.
Chapin, Ellis Warren, Jr., ¹ . . .	Chicopee Falls, . . .	Plant House.
Chase, Eleanor Frances, . . .	Amesbury, . . .	Draper Hall.
Clark, Clarence Frederick, . . .	Sunderland, . . .	Q. T. V.
Collins, Donald Keith, ¹ . . .	Rockland, . . .	Theta Chi.
Collins, Herbert Laurence, ¹ . . .	Arlington, . . .	Sigma Phi Epsilon.
Cook, Frederick Belcher, . . .	Niantic, Conn., . . .	Commons Club.
Cotton, George Asa, . . .	Woburn, . . .	84 Pleasant Street.
Crawford, Alexander George, . . .	Waverley, . . .	14 South College.
Crichton, Peter Andrew, ¹ . . .	Greenwich, Conn., . . .	Kappa Sigma.
Davis, Harold Sanborn, ¹ . . .	Belchertown, . . .	Belchertown.
Degener, Otto, ¹ . . .	New York, N. Y., . . .	The Davenport.
DuBois, Howard Grace, . . .	Springfield, . . .	Kappa Sigma.
Erysian, Harry Adrian, ¹ . . .	Chelsea, . . .	North College.
Farwell, Charles Austin, ¹ . . .	Turners Falls, . . .	10 South College.
Field, Richard Edmund, . . .	Shelburne Falls, . . .	Q. T. V.
Freeman, Stanley Leonard, . . .	Needham, . . .	Lambda Chi Alpha.
Frilen, Karl Arvid, ¹ . . .	West Springfield, . . .	Alpha Gamma Rho.
Gilbert, Frank Albert, Jr., . . .	Brandon, Vt., . . .	Lambda Chi Alpha.
Giles, Clifton Forrest, . . .	Newtonville, . . .	18 Nutting Avenue.
Gowdy, Carlyle Hale, . . .	Westfield, . . .	Sigma Phi Epsilon.
Haskins, Philip Hall, ¹ . . .	North Amherst, . . .	North Amherst.
Higgin, Albert Snyder, ¹ . . .	Passaic, N. J., . . .	12 South College.
Hodgson, Robert Moore, ¹ . . .	Boston, . . .	The Davenport.
Holman, Reginald Newton, . . .	Somerville, . . .	Q. T. V.
Hooper, Francis Edwards, . . .	Revere, . . .	Sigma Phi Epsilon.
Hurder, Ruth Wasson, ¹ . . .	Mattapan, . . .	Draper Hall.
Hussey, Francis William, ¹ . . .	Whitinsville, . . .	7 Nutting Avenue.
Jackson, Belding Francis, . . .	Belchertown, . . .	Belchertown.
Johnson, Conrad John, . . .	Poplar, Wis., . . .	Lambda Chi Alpha.
Kemp, George Austin, . . .	North Andover, . . .	Lambda Chi Alpha.
Knapp, Irving Robinson, ¹ . . .	Seekonk, . . .	116 Pleasant Street.
Kokoski, Frank Joseph, ¹ . . .	Hadley, . . .	Amherst, R. F. D. No. 3.
Kroeck, Julius, Jr., ¹ . . .	Huntington, N. Y., . . .	Phi Sigma Kappa.
Lacroix, Donald Sewall, ¹ . . .	Rowley, . . .	Alpha Gamma Rho.
Lawrence, Robert Parker, . . .	East Greenwich, R. I., . . .	12 North College.
Leland, James Freeman, Jr., ¹ . . .	Sherborn, . . .	10 South College.
Leonard, Earle Stanley, ¹ . . .	Hyde Park, . . .	Lambda Chi Alpha.
Lewandowski, John Neptumcen, ¹ . . .	Easthampton, . . .	Alpha Sigma Phi.
Lindquist, Harry Gotfred, ¹ . . .	Holden, . . .	3 North College.
Lingham, Robert Marston, . . .	Newton Highlands, . . .	Q. T. V.
Lockhart, John Harold, ¹ . . .	Tarrytown, N. Y., . . .	Stockbridge Hall.
Lovering, Everett Waldron, . . .	Northampton, . . .	Northampton.
Lowery, John Gordon, ¹ . . .	Malden, . . .	Kappa Sigma.
Lyons, Edgar Albion, . . .	Methuen, . . .	8 Kellogg Avenue.

¹ Work incomplete.

Lyons, John Joseph, Jr., ¹	Arlington,	Sigma Phi Epsilon.
MacArdle, Herbert Aloysius, ¹	Worcester,	Kappa Gamma Phi.
Main, Stuart DeGroff,	Maplewood, N. J.,	101 Butterfield Avenue.
Martin, Edward William, ¹	Amherst,	5 Phillips Street.
McGuinn, Albert Francis,	Worcester,	83 Pleasant Street.
Messenger, Herbert Dickinson, ¹	Cambridge,	8 North College.
Moody, Kenneth Watts,	Brookline,	Lambda Chi Alpha.
Moseley, Henry Samson, ¹	Glastonbury, Conn.,	Alpha Sigma Phi.
Murdock, Matthew John, ¹	Medford,	Q. T. V.
Murray, Harry Athol, Jr.,	Arlington,	West Experiment Station.
Murray, Myron George,	Bradford,	Lambda Chi Alpha.
Nigro, Henry, ¹	Revere,	1 North College.
Packer, George Blanchard, ¹	Waterbury, Conn.,	Sigma Phi Epsilon.
Peck, William Henry,	Stow,	12 North College.
Pickup, Ezra Alden,	Holyoke,	4 North College.
Pollard, Jane Isabel, ¹	North Adams,	Draper Hall.
Reed, Paul Malcolm, ¹	Baldwinsville,	Phi Sigma Kappa.
Richardson, Marjory,	Millis,	Draper Hall.
Rollins, Walter Jessie,	Leominster,	North College.
Roser, Conrad Herman, ¹	Glastonbury, Conn.,	Phi Sigma Kappa.
Russell, Ralph, ¹	Worcester,	Commons Club.
Sherman, Kenneth David, ¹	Orange,	North College.
Smith, Maxfield Merriam, ¹	Pittsfield,	23 East Pleasant Street.
Smith, Rowland Piper,	North Amherst,	46 Pleasant Street.
Smith, Stuart Van Alstyne, ¹	Springfield,	Kappa Sigma.
Spring, Hobart Wadsworth, ¹	Braintree,	Q. T. V.
Stephan, Henry Wesley, ¹	Brooklyn, N. Y.,	1 North College.
Stevens, Seth Edward,	Reading,	Kappa Sigma.
Sullivan, Joseph Timothy,	Lawrence,	Alpha Gamma Rho.
Swift, Arthur Lawrence,	North Amherst,	North Amherst.
Talmage, Harry John,	Great Barrington,	120 Pleasant Street.
Tanner, Willis,	Worcester,	Plant House.
Thompson, George Henry, Jr.,	Lenox,	84 Pleasant Street.
Tucker, Francis Sample, ¹	Arlington,	4 Nutting Avenue.
Vinten, Charles Raymond, ¹	Roxbury,	8 South College.
Walker, Philip Duane,	Hardwick,	10 South College.
Walsh, John Leonard, ¹	Amherst,	35 East Pleasant Street.
Warren, Edwin Herbert,	Chelmsford,	Lambda Chi Alpha.
Waugh, Frederick Vail,	Amherst,	Kappa Sigma.
Wentsch, Harold Earle, ¹	Southbury, Conn.,	Kappa Gamma Phi.
Whitaker, Carl Fales, ¹	Hadley,	Kappa Sigma.
White, George Edwin, ¹	Worcester,	Kappa Gamma Phi.
Whittemore, Alfred Lincoln, ¹	South Hadley Falls,	Lambda Chi Alpha.
Wildner, Edwin Lincoln, ¹	Holyoke,	Kappa Sigma.

PROVISIONAL SOPHOMORES.²

Arms, Richard Woodworth,	Hopkinton,	Kappa Gamma Phi.
Conant, Luman Binney,	Waltham,	4 Nutting Avenue.
Eastwood, John Edgar,	Plymouth,	5 Fearing Street.
Krasker, Abraham,	Boston,	7 South College.
Law, Hervey Fuller,	Longmeadow,	care of C. W. Everson.
Randall, Kenneth Charles,	Springfield,	care of C. W. Everson.
Smith, Albert William,	Easthampton,	Alpha Sigma Phi.
Taylor, Clarence Leo,	Jamaica Plain,	116 Pleasant Street.

CLASS OF 1923 (FRESHMEN).

Abele, Trescott Tupper,	Quincy,	16 North College.
Alexander, Donald Briggs,	Roxbury,	29 North Prospect Street.
Alger, Mason Williams,	West Bridgewater,	15 North College.

¹ Work incomplete.² Admitted from Special S. A. T. C. or from service of army or navy. Entrance record not yet complete.

Ames, Nathaniel Jackson, ¹	Peabody,	Kappa Sigma.
Arrington, Luther Bailey, ¹	Florence,	6 Nutting Avenue.
Baker, George Eugene,	Pleasantville, N. Y.,	70 Lincoln Avenue.
Baker, Howard, ¹	Marshfield,	7 North College.
Bartlett, Warren Leslie, ¹	Roslindale,	3 Nutting Avenue.
Bateman, Eleanor Willard,	Arlington Heights,	Draper Hall.
Bates, Howard, ¹	Cohasset,	101 Pleasant Street.
Bates, Robert Brooks, ¹	West Springfield,	30 North Prospect Street.
Beal, James Allen,	Abington,	101 Pleasant Street.
Blanchard, Edward Rollin,	Uxbridge,	7 Phillips Street.
Bock, Erwin Jardine, ¹	Springfield,	30 North Prospect Street.
Boles, Inza Almena, ¹	Dorchester,	Draper Hall.
Borgeson, Melvin Benjamin, ¹	Worcester,	21 Fearing Street.
Brewer, Gardner Hunter,	Upton,	10 North College.
Broderick, Lawrence Francis,	Hyde Park,	19 South Prospect Street.
Buckley, Francis Edward, ¹	Natick,	35 North Prospect Street.
Burke, Edmund William,	Watertown,	9 North College.
Cohen, Solomon, ¹	Dorchester,	6 North College.
Corash, Paul,	Worcester,	56 Pleasant Street.
Davis, Frank Langdon, ¹	Lexington,	M. A. C. Farmhouse.
Davis, William, ¹	North Adams,	3 East Pleasant Street.
Dickinson, Lewis Everett, Jr.,	Holyoke,	4 North College.
Dimock, Walter Lewis,	Oxford,	17 Fearing Street.
Downen, Philip Berry, ¹	Sandwich,	16 North College.
Faneuf, John Benedict,	West Warren,	Chemistry Laboratory.
Fetter, George Andrew,	Watertown,	35 North Prospect Street.
FitzGerald, David Francis,	Holyoke,	4 Chestnut Street.
Fitzpatrick, Leo Joseph,	Brockton,	Mount Pleasant.
Folsom, Owen Eugene, ¹	Roslindale,	3 Nutting Avenue.
Friend, Roger Boynton,	Dorchester,	15 Hallock Street.
Fuller, Robert Donald,	Woburn,	7 North College.
Gamzue, Benjamin, ¹	Holyoke,	56 Pleasant Street.
Gaskill, Millard Thayer,	Hopedale,	Alpha Sigma Phi.
Gay, Alfred Fullick,	Groton,	83 Pleasant Street.
Gildemeister, Mary Katherine, ¹	West Springfield,	Draper Hall.
Gordon, Howard Reynolds,	Ipswich,	101 Pleasant Street.
Grayson, Raymond Henry, ¹	Milford,	120 Pleasant Street.
Groves, Alan Marston,	Newton Center,	13 North College.
Hale, John Stancliff,	South Glastonbury, Conn.,	66 Pleasant Street.
Hardy, Sherman Keeler,	Littleton,	9 Fearing Street.
Harrington, Robert John,	Holyoke,	83 Pleasant Street.
Heath, Allan Jay,	Newfane, Vt.,	5 North College.
Hilyard, Norman Douglas,	Beverly,	120 Pleasant Street.
Hobart, Charles Harrison,	Boston,	73 Pleasant Street.
Hodsdon, Marshall Sinclair,	Melrose Highlands,	66 Pleasant Street.
Hubbard, James Sumner,	Sunderland,	17 Phillips Street.
Hunter, Henry Leander, Jr.,	Mount Kisco, N. Y.,	31 Lincoln Avenue.
Irish, Gilbert Henry,	Turner, Me.,	North Amherst.
Isaac, Carl Frederick, ¹	Brighton,	35 North Prospect Street.
Johnson, Cleon Bancroft,	Ipswich,	101 Pleasant Street.
Johnson, Eyrle Gray, ¹	Dorchester,	45 East Pleasant Street.
Jones, Alan, ¹	Boston,	35 North Prospect Street.
Labrovitz, Rose Florence,	Amherst,	11 Amity Street.
Latour, Oliver Page,	Spencer,	6 Nutting Avenue.
Lewis, Molly LeBaron,	Jamaica Plain,	Draper Hall.
Lindskog, Gustaf Elmer Richard,	Roxbury,	6 North College.
Luddington, Frank Dennison, ¹	Hamden, Conn.,	125 South Pleasant Street.
MacCready, Donald Eugene, ¹	Elizabeth, N. J.,	4 Chestnut Street.
Malley, Joseph Anthony, ¹	Watertown,	35 North Prospect Street.
Marshman, Wilbur Horace, ¹	Springfield,	23 East Pleasant Street.
Martin, Frances Barbara,	Amherst,	5 Phillips Street.
Martin, Robert Fitz-Randolph,	Springfield,	53 Lincoln Avenue.

¹ Work incomplete.

Mather, Edna, ...	Amherst, ...	5 Allen Street.
McCabe, Raymond Salter, ...	Holyoke, ...	83 Pleasant Street.
McKenzie, David Hamilton, ¹	Thorndike, ...	McClure Street.
Midgley, William Bancroft, ¹	Worcester, ...	30 North Prospect Street.
Mitsui, Takasada, ...	New York, N. Y., ...	34 North Prospect Street.
Mohor, Robert deSales, ¹	Newton Center, ...	13 North College.
Morris, Walter Markley, ¹	Amherst, ...	66 Pleasant Street.
Mudgett, Vernon Downer, ...	Sterling Junction, ...	8 North College.
Newell, Richard Carll, ...	West Springfield, ...	Cottage Street.
Newton, Payson Taft, ...	Holyoke, ...	21 Fearing Street.
Nicholson, Donald Albert, ...	Lynn, ...	17 Fearing Street.
Paddock, Wallace Earl, ...	Worcester, ...	M. A. C. Farmhouse.
Perry, Chauncey Valentine, ...	Waltham, ...	17 Kellogg Avenue.
Phelps, Harley Procter, ...	South Williamstown, ...	120 Pleasant Street.
Picard, Charles Francis, ¹	Plymouth, ...	15 Fearing Street.
Ribero, Edwin Francis, ...	Franklin, ...	9 South College.
Roberts, Arthur William, ¹	Hyde Park, ...	9 North College.
Sargent, Richmond Holmes, ...	Buxton, Me., ...	101 Pleasant Street.
Searles, Gilbert Brundage, ...	Lake Mohegan, N. Y., ...	66 Pleasant Street.
Sears, Fred Grant, Jr., ...	Dalton, ...	23 East Pleasant Street.
Shea, Thomas Francis, ...	Holyoke, ...	36 North Prospect Street.
Sherman, Bradford Pierce, ...	New Bedford, ...	13 Fearing Street.
Slade, Irving Woodman, ...	Chelsea, ...	53 Lincoln Avenue.
Smith, Jeffrey Poole, ...	West Roxbury, ...	14 North College.
Smith, Richard Burr, ¹	Greenfield, ...	15 Fearing Street.
Snow, Thomas Lathrop, ...	Greenfield, ...	15 North College.
Sullivan, Catherine Elisabeth, ...	Amherst, ...	25 Gray Street.
Tanner, Edwin, ...	Worcester, ...	Plant House.
Tarplin, Allan Sebastian, ...	Brookline, ...	56 Pleasant Street.
Tarr, James Gordon, ...	Everett, ...	29 North Prospect Street.
Task, Mortimer, ...	West Stoughton, ...	North College.
Tileston, Roger Gordon, ...	Sharon, ...	18 Nutting Avenue.
Tisdale, Edward Norman, ...	Medfield, ...	13 Fearing Street.
Towne, Carroll Alden, ...	Auburndale, ...	83 Pleasant Street.
Towne, Warren Hannaford, ...	Cambridge, ...	5 North College.
Tumey, Malcomb Edward, ...	Deerfield, ...	120 Pleasant Street.
Turner, Dorothy Van Hoven, ...	Amherst, ...	Draper Hall.
Wendell, Richard Goodwin, ...	Belmont, ...	15 North College.
Whitaker, Holden, ...	Newton Highlands, ...	83 Pleasant Street.
Whittier, John McKey, ...	Everett, ...	15 Fearing Street.
Williams, Forrest Earl, ...	Sunderland, ...	17 Phillips Street.
Wilson, Albert Arthur, ...	Boston, ...	18 Nutting Avenue.
Wilson, John Jacob, ...	Boston, ...	18 Nutting Avenue.
Wirth, Conrad Louis, ¹	Minneapolis, Minn., ...	9 Nutting Avenue.
Woodworth, Leverett Stearns, ...	Newton, ...	North Amherst.

PROVISIONAL FRESHMEN.²

Arnold, Isaac, ...	Boston, ...	56 Pleasant Street.
Atkins, Cecil Everett, ...	Beverly, ...	35 North Prospect Street.
Bastille, Joseph Thomas, ...	Amherst, ...	120 Pleasant Street.
Burbeck, Joseph Howard, ...	Peabody, ...	15 Phillips Street.
Cady, Howard Meader, ...	South Shaftsbury, Vt., ...	13 South Prospect Street.
Dowd, Henry Clement, ...	Holyoke, ...	36 North Prospect Street.
Gerry, Bertram Irving, ...	Peabody, ...	18 Nutting Avenue.
Goldstein, Joseph, ...	Lynn, ...	56 Pleasant Street.
Holley, George Gilbert, ...	Fiskdale, ...	13 Fearing Street.
Hollis, Frederick Allen, ³	Charlton, ...	35 North Prospect Street.
Lewis, Bert Morton, ...	Northampton, ...	Northampton.
Nowers, Donald Gifford, ...	Danvers, ...	45 East Pleasant Street.

¹ Work incomplete.² Admitted on service record in either army or navy. Entrance record not complete.³ Admitted on scholarship probation. Entrance record not yet complete.

Putnam, Ernest Taylor, . . .	Greenfield, . . .	care of L. H. Taylor.
Sandow, Alexander, ¹ . . .	Pittsfield, . . .	23 East Pleasant Street.
White, Ralph Harold, . . .	Barnard, Vt., . . .	101 Pleasant Street.

UNCLASSIFIED STUDENTS.

Browning, Joan Ruth, . . .	Springfield, . . .	Draper Hall.
Burgess, Almora Watson, . . .	Plymouth, . . .	15 Fearing Street.
Coles, Howard Finlay, . . .	Tarrytown, N. Y., . . .	Theta Chi.
Crocker, Mrs. Elsie Venner, . . .	North Amherst, . . .	North Amherst.
Cummings, Leslie Samuel, . . .	Webster, . . .	120 Pleasant Street.
Dalrymple, George Benjamin, . . .	Plainfield, . . .	M. A. C. Farmhouse.
Farnham, George Ellison, . . .	Peabody, . . .	3 Nutting Avenue.
Gilbert, Marion, . . .	Great Barrington, . . .	29 Lincoln Avenue.
Glatzerman, Benjamin, . . .	Lebanon, Conn., . . .	56 Pleasant Street.
Goodale, Geoffrey Dearborn, . . .	Ipswich, . . .	The Davenport.
Green, Howard Emery, . . .	Westfield, . . .	McClure Street.
Gustin, Francis Borden, . . .	North Amherst, . . .	North Amherst.
Hansen, Ernest, . . .	Worcester, . . .	18 Nutting Avenue.
Hart, Owen Stephen, . . .	Meriden, Conn., . . .	6 Nutting Avenue.
Hemenway, Rachel Viola, . . .	Williamsburg, . . .	Draper Hall.
Hooper, Oliver Furbish, . . .	East Lynn, . . .	Kappa Gamma Phi.
Itano, Mrs. Arao, . . .	Amherst, . . .	7 East Pleasant Street.
Johnson, Francis Wesley, . . .	Springfield, . . .	53 Lincoln Avenue.
Knapp, Fanny Carter, . . .	Lowell, . . .	Draper Hall.
McCarthy, Jeremiah Joseph, Jr., . . .	Newton, . . .	15 Hallock Street.
McNamara, James Joseph, . . .	South Boston, . . .	3 Nutting Avenue.
Morse, Mrs. Betty Strome, . . .	Amherst, . . .	18 Nutting Avenue.
Novitski, Joseph Francis, . . .	Amherst, . . .	6 Phillips Street.
Perry, John Tuttle, . . .	Waltham, . . .	17 Kellogg Avenue.
Richardson, Lester Thornley, . . .	Waltham, . . .	7 Nutting Avenue.
Smith, Sydney Alexander, . . .	Worcester, . . .	25 Lincoln Avenue.
Stevens, Richard Clinton, . . .	Winchester, . . .	17 Fearing Street.
Stockbridge, John Sylvester, . . .	Atlanta, Ga., . . .	Kappa Sigma.
Tattan, Francis David, . . .	Cambridge, . . .	4 Chestnut Street.
Tierney, Grace Elizabeth, . . .	Holyoke, . . .	Draper Hall.
Tracy, Ralph Prior, . . .	Winchendon, . . .	Poultry Plant.
Wendler, Henry George, . . .	Clinton, . . .	Stockbridge Hall.
Whitney, Clara Frances, . . .	Boston, . . .	Draper Hall.

GEOGRAPHICAL SUMMARY.

Massachusetts, ...	446
Connecticut, ...	18
New York, ...	16
Vermont, ...	5
New Jersey, ...	5
Maine, ...	4
Rhode Island, ...	3
New Hampshire, ...	2
California, ...	2
Canada, ...	2
Alabama, ...	1
Delaware, ...	1
District of Columbia, ...	1
Georgia, ...	1
Illinois, ...	1
Indiana, ...	1
Kentucky, ...	1
Maryland, ...	1
Minnesota, ...	1
Missouri, ...	1

¹ Admitted on scholarship probation. Entrance record not yet complete.

[illegible]

SUMMARY BY CLASSES.

CLASS.	Men.	Women.	Total.
Graduate students, ...	31	2	33
Senior class, 1920, ...	110	3	113
Junior class, 1921, ...	100	3	103
Sophomore class, 1922, ...	100	4	104
Provisional sophomores, ...	8	-	8
Freshman class, 1923, ...	101	9	110
Provisional freshmen, ...	15	-	15
Unclassified students, ...	24	9	33
Total, ...	489	30	519

SHORT COURSE ENROLLMENT.

TWO-YEAR COURSE, 1919-20.

Adams, George William, ...	Pittsfield, ...	5 Kendrick Place.
Allen, Chester Carolton, ...	West Rutland, ...	120 Pleasant Street.
Almy, Roger Warren, ...	New Bedford, ...	10 North College.
Amsden, Maude Ella, ...	Petersham, ...	Mount Pleasant.
Anderson, Walter Raldolph, ...	East Pepperell, ...	34 North Prospect Street.
Andrews, Harold Leslie, ...	Stafford, Conn., ...	15 Amity Street.
Arel, Theophile, ...	Holyoke, ...	15 Phillips Street.
Arp, Dietrich, ...	Milwaukee, Wis., ...	36 North Prospect Street.
Arruda, Anthony Peter, ...	New Bedford, ...	36 North Prospect Street.
Ashforth, Arthur Clifton, ...	Brockton, ...	70 Lincoln Avenue.
Baird, Francis William, ...	Waltham, ...	7 Nutting Avenue.
Barrows, Edward Fletcher, ...	Brattleboro, Vt., ...	75 Pleasant Street.
Barrows, Harold Clayton, ...	Mendon, ...	20 Lessey Street.
Baxter, Samuel Ballantine, ...	Tenafly, N. J., ...	5 Kendrick Place.
Bemis, Raymond Battles, ...	Spencer, ...	15 Phillips Street.
Bennett, William Whytal, ...	Arlington, ...	101 Pleasant Street.
Blumen, David, ...	Smolensk, Russia, ...	101 Pleasant Street.
Bobb, Linn, ...	Philadelphia, Pa., ...	Mount Pleasant.
Bronsdon, William Abbott, ...	Baldwinsville, ...	75 Pleasant Street.
Brooker, John Patrick, ...	Roxbury, ...	34 Pleasant Street.
Bruce, Mary Elizabeth, ...	Dorchester, ...	79 Pleasant Street.
Bryant, Frank Kenneth, ...	Lowell, ...	8 Kellogg Avenue.
Burke, Leslie Joseph, ...	Medford, ...	12 Cottage Street.
Burnett, Marston, ...	Cambridge, ...	14 Nutting Avenue.
Burnham, Theodore Shelley, ...	Essex, ...	53 Lincoln Avenue.
Burrington, Raymond Wells, ...	North Amherst, ...	North Amherst.
Burrington, Reginald Clifton, ...	North Amherst, ...	North Amherst.
Butler, James Stoddard, ...	Keene, N. H., ...	-
Carpenter, Ruth, ...	Hudson, ...	Draper Hall.
Carroll, Margaret Adelaide, ...	Dorchester, ...	Draper Hall.
Chace, Chester William, ...	Springfield, ...	3 Nutting Avenue.
Chadwick, Walter, ...	Lawrence, ...	20 Lessey Street.
Chandler, Donald Carlyle, ...	New Gloucester, Me., ...	15 Hallock Street.
Chapel, Walter, ...	Bolton, ...	36 North Prospect Street.
Chrisfield, Edward Richardson, ...	Needham, ...	101 Pleasant Street.
Christensen, Frank William, ...	North Easton, ...	13 Phillips Street.
Clapp, Horace Damon, ...	Easthampton, ...	8 Kellogg Avenue.
Clark, Chester Frederic, ...	Fitchburg, ...	North Amherst.
Clark, Elbridge Theodore, ...	Millis, ...	45 East Pleasant Street.
Clark, William Guster, ...	Amherst, ...	11 Amity Street.
Colton, Hartman Dudley, ...	Springfield, ...	45 Pleasant Street.
Connor, Raymond James, ...	Worcester, ...	52 Lincoln Avenue.
Conroy, Maurice, ...	New Bedford, ...	West Experiment Station.
Converse, John Kendrick, ...	Andover, ...	79 Pleasant Street.
Corey, Raymond Stanley, ...	Amherst, ...	35 East Pleasant Street.
Cornell, Ivan Manley, ...	Brookline, ...	36 North Prospect Street.
Crocker, Fred Carlton, ...	North Adams, ...	35 East Pleasant Street.
Crosby, Leon Rolland, ...	Tyngsborough, ...	34 Pleasant Street.
Crowell, Homer Merrill, ...	New York, N. Y., ...	35 East Pleasant Street.
Currier, Napoleon, ...	Lawrence, ...	108 Pleasant Street.
Danske, Frank, ...	Holyoke, ...	35 East Pleasant Street.

Davis, Frederick Oscar, . . .	Windsor, Vt., . . .	21 Amity Street.
Day, Roland Wight, . . .	Medfield, . . .	83 Pleasant Street.
Dill, Clarence Elmer, . . .	Raynham Center, . . .	North Amherst.
Doane, Robert Allen, . . .	North Brookfield, . . .	70 Lincoln Avenue.
Dole, Stevens Field, . . .	Greenfield, . . .	45 Pleasant Street.
Douglas, Harry Lawton, . . .	Lowell, . . .	M. A. C. Farmhouse.
DuFresne, Francis Armand, . . .	Lenox, . . .	North Amherst.
Dunbar, Charles Basil, . . .	Taunton, . . .	Ye Aggie Inn.
Eastman, Roger Austin, . . .	Amherst, . . .	North Amherst.
Estey, Roger Bradshaw, . . .	Somerville, . . .	6 Kellogg Avenue.
Faufaw, R. W., . . .	Derby Line, Vt., . . .	36 North Pleasant Street.
Finn, William Francis, . . .	Chelsea, . . .	North Amherst.
Firth, Frank Lemuel, . . .	Worcester, . . .	81 Pleasant Street.
Flanders, John Leonard, Jr., . . .	Southville, . . .	20 Lessey Street.
Ford, Clarence Eugene, . . .	St. Louis, Mo., . . .	Eames Street.
Frary, Frank Taylor, . . .	Southampton, . . .	8 Kellogg Avenue.
Gibbons, William Frank, . . .	Fitchburg, . . .	120 Pleasant Street.
Gifford, Franklin Maynard, Jr., . . .	Middleborough, . . .	34 North Prospect Street.
Girard, Albert John, . . .	East Brimfield, . . .	29 East Pleasant Street.
Graeff, Charles Albert, . . .	New York, N. Y., . . .	Sunderland.
Greenfield, Abraham, . . .	Springfield, . . .	4 Chestnut Street.
Grieve, Alexander Watson, . . .	Dorchester, . . .	7 Nutting Avenue.
Gruver, Raymond Charles, . . .	Lowell, . . .	35 Northampton Road.
Gustafson, Gustaf Albert, . . .	Wilmington, . . .	North Pleasant Street.
Hall, Robert Hancock, . . .	Waverley, . . .	35 East Pleasant Street.
Hamilton, Grant Ethan, . . .	Cyrus, . . .	20 Lessey Street.
Hamilton, Weston Alexander, . . .	Salem, . . .	13 Phillips Street.
Hancock, Russell Hagen, . . .	Vineyard Haven, . . .	18 Nutting Avenue.
Hanifin, Robert Emmett, . . .	Belchertown, . . .	10 Maple Avenue.
Hare, Ambrose Henry, . . .	Leominster, . . .	71 South Pleasant Street.
Hartwell, Nathan Haywood, . . .	Rockland, . . .	4 Nutting Avenue.
Hartwell, Robert Mantor, . . .	Buckland, . . .	M. A. C. Farmhouse.
Haskell, Wilder Alexander, . . .	Holyoke, . . .	North Amherst.
Hawes, Leon Roy, . . .	Sudbury, . . .	33 East Pleasant Street.
Hayden, Arthur Leo, . . .	Natick, . . .	35 North Prospect Street.
Hayes, William Bointon, . . .	South Deerfield, . . .	120 Pleasant Street.
Heffernan, Cyril James, . . .	Dorchester, . . .	12 McClure Street.
Heinlein, Edward Bancroft, . . .	South Natick, . . .	17 Pleasant Street.
Hoyt, Perley Luther, . . .	Perkinsville, Vt., . . .	20 Lessey Street.
Hubbell, James Platt, . . .	Boston, . . .	36 North Prospect Street.
Huckins, Norman Charles, . . .	Dorchester, . . .	9 Fearing Street.
Huntley, Robert Ernest, . . .	Somerville, . . .	73 Pleasant Street.
Igo, Bernard James, . . .	West Somerville, . . .	101 Pleasant Street.
Jacques, John William, . . .	Malden, . . .	60 Pleasant Street.
Jauncey, Oakleigh Wells, . . .	Williamstown, . . .	36 North Prospect Street.
Jewett, Joseph Winthrop, . . .	Arlington, . . .	23 East Pleasant Street.
Johnson, William James, . . .	Medford, . . .	7 Nutting Avenue.
Jordan, Emmett Philmore, . . .	Smithfield, Va., . . .	101 Pleasant Street.
Kallio, Toivo Matthew, . . .	Middlefield, . . .	8 North Prospect Street.
Keller, Earle Franklin, . . .	Augusta, Me., . . .	4 Chestnut Street.
Kelley, John Joseph, . . .	Amherst, . . .	71 South Pleasant Street.
Kilton, Donald Gilbert, . . .	Worcester, . . .	79 Pleasant Street.
Kimball, Elforest Franklin, . . .	Danvers, . . .	34 Pleasant Street.
Kimball, Howard Augustus, . . .	Littleton, . . .	9 Fearing Street.
Kirchner, Robert Walter, . . .	Pittsfield, . . .	40 Mount Pleasant.
Knight, Henry Elbridge, . . .	Easton, Me., . . .	20 Lessey Street.
Knight, Herbert Allen, . . .	Ludlow, . . .	45 Pleasant Street.
Komla, Stanley, . . .	Cambridge, . . .	101 Pleasant Street.
Krikorian, Krikor Hovaness, . . .	Bridgeport, Conn., . . .	12 Cottage Street.
Landstrom, Oscar Nathaniel, . . .	Heath, . . .	5 Nutting Avenue.
Langelier, Edgar Joseph, . . .	Lynn, . . .	18 Nutting Avenue.
Lawrence, Harold Tildon, . . .	Rhodesia, South Africa, . . .	29 Northampton Road.
Lawson, John Thomas, . . .	New Bedford, . . .	60 Pleasant Street.
Leone, Anthony, . . .	Boston, . . .	North Amherst.

Libby, Ben Frank, . . .	Springfield, . . .	Experiment Station.
Libby, Carl Estes, . . .	Springfield, . . .	East Experiment Station.
Loomer, Gordon Powell, . . .	Waverley, . . .	4 Chestnut Street.
Lord, George Walker, . . .	Framingham, . . .	70 Lincoln Avenue.
Lounsbury, Francis Edward, . . .	Cambridge, . . .	101 Pleasant Street.
MacLeod, Norman Frederick, . . .	Lynn, . . .	35 North Prospect Street.
MacMillan, Murray, . . .	Medford, . . .	36 North Prospect Street.
Mahakian, John, . . .	Boston, . . .	4 Chestnut Street.
Malhoit, Alfred William, . . .	Worcester, . . .	R. F. D. No. 3, Amherst.
Mason, Gerald Joe, . . .	Barre, Vt., . . .	North Pleasant Street.
Maxson, John Warren, . . .	Philadelphia, Pa., . . .	21 Fearing Street.
McCluskey, Joseph James, . . .	Bangor, Me., . . .	101 Pleasant Street.
McFarlan, John Wesley, . . .	Cincinnati, O., . . .	75 Pleasant Street.
McGilvery, Peter Joseph, . . .	Cambridge, . . .	3 Pleasant Street.
Miller, Fred Reuben, . . .	Barnardston, . . .	20 Lessey Street.
Moczarski, Joseph, . . .	Holyoke, . . .	Triangle Street.
Morse, Harold Sterling, . . .	Arlington, . . .	23 East Pleasant Street.
Morse, Herbert Edgar, . . .	Foxborough, . . .	48 Nutting Avenue.
Mullen, Frank Myles, . . .	Fayville, . . .	44 Triangle Street.
Mumford, William Henry, . . .	Springfield, . . .	36 North Prospect Street.
Narkin, Isadore, . . .	Philadelphia, Pa., . . .	75 Pleasant Street.
Newell, Joseph Delaplane, . . .	Brooklyn, N. Y., . . .	Inwood.
Newhall, Gordon William, . . .	Brookline, . . .	45 Pleasant Street.
Norris, Frank White, . . .	Dorchester, . . .	12 Cottage Street.
Nowers, Rodman Clark, . . .	Danvers, . . .	45 East Pleasant Street.
Oakes, John Joseph, . . .	Wellesley, . . .	17 Pleasant Street.
O'Brien, Katherine Frances, . . .	Lawrence, . . .	29 Lincoln Avenue.
O'Shan, David, . . .	New York, N. Y., . . .	47 Pleasant Street.
Owens, Zorayda Kathleen, . . .	Haverhill, . . .	29 Lincoln Avenue.
Parkes, Charles Ransom, . . .	New York, N. Y., . . .	120 Pleasant Street.
Parsons, Phillips Henry, . . .	Southampton, . . .	79 Pleasant Street.
Peirce, Albert Kimball, . . .	Arlington, . . .	101 Pleasant Street.
Pellis, Abraham, . . .	Chelsea, . . .	41 Pleasant Street.
Percy, Minot Simons, . . .	Arlington, . . .	101 Pleasant Street.
Perkins, George Burton, . . .	Woburn, . . .	21 Fearing Street.
Phipps, Carleton Lawrence, . . .	Holliston, . . .	60 Pleasant Street.
Pickard, Herbert Peirce, . . .	Concord Junction, . . .	17 Kellogg Avenue.
Porrovecchio, Carl James, . . .	Charlemont, . . .	5 Nutting Avenue.
Potwin, Bert Louis, . . .	Woodstock, Conn., . . .	35 East Pleasant Street.
Purdy, Donald Ring, . . .	Waverley, . . .	4 Chestnut Street.
Quinn, William Robert, . . .	Natick, . . .	34 Pleasant Street.
Raymond, Matthew George, . . .	Boston, . . .	108 Pleasant Street.
Reid, Howard Stanton, . . .	Franklin, . . .	9 South College.
Richards, Osgood Samuel, . . .	Jamaica Plain, . . .	32 North Prospect Street.
Rideout, Lawrence Walter, . . .	Amherst, . . .	17 Kellogg Avenue.
Ripley, Lucien Lawrence, . . .	Montague, . . .	17 Cottage Street.
Robinson, Frederick Charles, . . .	Westford, . . .	54 Pleasant Street.
Rollins, Guy Emery, . . .	Selden, Me., . . .	3 Nutting Avenue.
Root, Howard Chapin, . . .	Colrain, . . .	20 Lessey Street.
Rossier, Hardy Samuel, . . .	Newport, Vt., . . .	17 Kellogg Avenue.
Rowe, Everett Elliot, . . .	Bolton, . . .	53 Lincoln Avenue.
Rowe, George Joseph, . . .	Greenfield, . . .	66 Pleasant Street.
Rowe, Herbert Malcolm, . . .	Beverly, . . .	116 Pleasant Street.
Ruggieri, Salver, . . .	Summit, R. I., . . .	12 Cottage Street.
Russell, Paul Belford, . . .	West Medway, . . .	6 Nutting Avenue.
Sadowski, Stephen Anthony, . . .	South Boston, . . .	35 East Pleasant Street.
Savage, John Francis, . . .	Dorchester, . . .	71 South Pleasant Street
Sawyer, John Henry, . . .	North Brookfield, . . .	70 Lincoln Avenue.
Segelman, Max, . . .	Chelsea, . . .	9 Fearing Street.
Shaw, Charles Dudley, . . .	Westfield, . . .	13½ Amity Street.
Shaw, Walter Bruce, . . .	Sutton, . . .	8 Kellogg Avenue.
Shewlin, Frank James, . . .	Woonsocket, R. I., . . .	101 Pleasant Street.
Smith, Raymond Leslie, . . .	East Hartford, Conn., . . .	11 Triangle Street.
Smith, Royce Walter, . . .	Boston, . . .	4 Chestnut Street.

Snelling, Samuel William, . . .	Lincoln, . . .	4 Chestnut Street.
Spinney, Joseph Warren, . . .	Allston, . . .	25 Lincoln Avenue.
Spooner, Roy Adelbert, . . .	Dorchester, . . .	34 Pleasant Street.
Spooner, William Danforth, . . .	Brimfield, . . .	Waid Farm.
Spring, Earle Nelson, . . .	Millers Falls, . . .	M. A. C. Farmhouse.
Steele, Gordon Ells, . . .	Waverley, . . .	4 Chestnut Street.
Stiles, Allan Langille, . . .	Littleton, . . .	6 Nutting Avenue.
Sutherland, John Francis, . . .	South Boston, . . .	Mount Pleasant.
Talbot, William Joseph, . . .	Quincy, . . .	8 Hallock Street.
Taylor, Arthur Raymond, . . .	Framingham, . . .	13 Phillips Street.
Thorn, Henry Holton, . . .	Deerfield, . . .	120 Pleasant Street.
Trafton, Walter Richard, . . .	Swampscott, . . .	12 Cottage Street.
Van Derpoel, Ernest Collins, . . .	Chicopee Falls, . . .	33 East Pleasant Street.
Vartanian, Neshan, . . .	Indian Orchard, . . .	41 Pleasant Street.
Veselsak, Helen Clara, . . .	Westfield, . . .	Draper Hall.
Wackerbarth, William Rudolph, . . .	Morenci, Ariz., . . .	13 Phillips Street.
Walsh, John, Jr., . . .	Bedford, . . .	North Pleasant Street.
Ward, William David, . . .	Newton, . . .	44 Triangle Street.
Warner, Harry Freeman, . . .	Wollaston, . . .	7 Phillips Street.
Watson, Alan Wendell, . . .	Providence, R. I., . . .	17 Kellogg Avenue.
Whitecomb, Harold Adams, . . .	Concord Junction, . . .	6 Nutting Avenue.
White, Alice Louise, . . .	Bristol, Conn., . . .	Mount Pleasant.
Whitmore, Raymond Swett, . . .	Arlington Heights, . . .	4 Chestnut Street.
Wickwire, Harry Wyndom, . . .	Worcester, . . .	35 East Pleasant Street.
Wiggin, Theron Herman, . . .	Norwood, . . .	83 Pleasant Street.
Willson, Stewart Hemingway, . . .	Thompsonville, Conn., . . .	53 Lincoln Avenue.
Wilson, Harvey William, . . .	Boston, . . .	101 Pleasant Street.
Wolf, Henry, . . .	Amherst, . . .	4 Chestnut Street.
Wood, Matthew Arnold, . . .	South Portland, Me., . . .	6 Nutting Avenue.
Young, George Thomas, . . .	Wilkinsonville, . . .	8 Kellogg Avenue.

VOCATIONAL POULTRY COURSE.

Abair, Peter Dorcey, . . .	Worcester, . . .	41 Pleasant Street.
Abercrombie, Edward Marion, . . .	Greenfield, . . .	120 Pleasant Street.
Donovan, Albert Peter, . . .	New Brunswick, Can., . . .	70 Lincoln Avenue.
Follansbee, Harry Mayoh, . . .	Enfield, N. H., . . .	North Amherst.
Goodnow, Lewis Weston, . . .	Greenfield, . . .	15 Phillips Street.
Hatch, Henry Donald, . . .	Auburn, Me., . . .	29 North Prospect Street.
Jorgensen, George Arthur, . . .	Floral Park, N. Y., . . .	13½ Amity Street.
McFague, Maurice Graeme, . . .	Wollaston, . . .	70 Lincoln Avenue.
Mosher, Roy Wilson, . . .	East Bridgewater, . . .	36 North Prospect Street.
Nestle, Harold George, . . .	Amherst, . . .	Leverett Street.
Torrey, Hamilton, . . .	Springfield, . . .	118 Pleasant Street.
Von Bieberstein, Herbert, . . .	Boston, . . .	81 Pleasant Street.
Wenz, Philip Henry, . . .	East Dedham, . . .	North Amherst.

RURAL ENGINEERING COURSE.

Ash, Walter George, . . .	Anthony, R. I., . . .	75 Pleasant Street.
Burt, John Holton, . . .	Hyde Park, . . .	7 Phillips Street.
Clarke, William John, . . .	Ipswich, . . .	101 Pleasant Street.
Flanagan, Matthew Joseph, . . .	Roxbury, . . .	101 Pleasant Street.
French, Percy Jackson, . . .	Rockland, . . .	4 Chestnut Street.
Jarvis, Albert Arthur, . . .	East Boston, . . .	Sigma Phi Epsilon.
Landry, Theodore Joseph, . . .	New Brunswick, Can., . . .	101 Pleasant Street.
Logan, Michael John, . . .	Atlantic, . . .	37 Cottage Street.
MacDonnell, Charles Angus, . . .	Cambridge, . . .	3 Pleasant Street.
Mirault, Joseph Dustin, . . .	Holyoke, . . .	15 Phillips Street.
Nelson, Guy Leslie, . . .	Milford, N. H., . . .	71 South Pleasant Street.
Salo, Charles Raymond, . . .	Pittsfield, . . .	37 Cottage Street.
Sharp, James Milne, . . .	Dorchester, . . .	101 Pleasant Street.
Syrett, Clifford Franklin, . . .	Springfield, . . .	17 Kellogg Avenue.
Thoubboron, Frank William, . . .	Brooklyn, N. Y., . . .	39 Main Street.
Whitbeck, Henry, . . .	Alandar, . . .	5 McClellan Street.

SECOND SIX WEEKS' COURSE, 1919.

Ainsworth, Dean F.,	Springfield.
Carlson, Ralph,	East Longmeadow.
Daley, Edwin W., Jr.,	Boston.
Gould, Irvin T.,	Waverley.
Groeziuger, Christian,	Amherst.
Hartung, Robert R.,	Boston.
Parker, Reginald S.,	Cambridge.
Patch, Helen M.,	Beverly.
Williams, Fred B.,	Interlaken.

VOCATIONAL POULTRY COURSE, MARCH TO JUNE, 1919.

Etheridge, William H.,	Salem.
Goodnow, Lewis W.,	Greenfield.
Graves, Reginald S.,	Bridgeport, Conn.
Malhoit, Alfred W.,	Worcester.
McFague, Maurice G.,	Wollaston.
Vondell, John H.,	Windsor, Vt.

SUMMER COURSE FOR FEDERAL MEN, 1919.

Adams, Glenn W.,	Eden, Vt.
Ash, Walter G.,	Anthony, R. I.
Ashforth, Arthur C.,	Brockton.
Chace, Chester W.,	Springfield.
Christensen, Frank W.,	North Easton.
Corey, Raymond S.,	Raynham Center.
Crocker, Fred C.,	North Adams.
Currier, Napoleon,	Lawrence.
Donovon, Albert P.,	New Brunswick, Can.
Flanagan, Matthew J.,	Roxbury.
Gibbons, William F.,	Fitchburg.
Hamilton, Weston A.,	Salem.
Igo, Bernard J.,	West Somerville.
Komla, Stanley,	Cambridge.
Lounsbury, Francis E.,	Cambridge.
Malhoit, Alfred W.,	Worcester.
McFarlan, John W.,	Cincinnati, O.
McGrath, Edward J.,	New Bedford.
Mirault, Joseph D.,	Holyoke.
Narkin, Isadore,	Boston.
Potwin, Bert L.,	Woodstock, Conn.
Ralls, Myles F.,	Lowell.
Raymond, Matthew G.,	Boston.
Rollins, Guy E.,	Selden, Me.
Rowe, George J.,	Greenfield.
Shevlin, Frank J.,	Woonsocket, R. I.
Talbot, William J.,	Quincy.
Vayo, William B.,	Worcester.
Wackerbarth, William B.,	Morenci, Ariz.
Whitbeck, Henry,	Alandar.
Wilson, Harvey W.,	Boston.

SUMMER SCHOOL, 1919.

Allen, Roland H.,	Auburndale.
Allen, Wendell P.,	Auburndale.
Alley, Evelyn L.,	Hyde Park.
Anderson, Paul J.,	Amherst.
Archibald, Edith M.,	Waltham.
Armor, Mira L.,	Marshallton, Del.
Bader, Annetta M.,	Shelburne Falls.
Baker, Florence M.,	Amherst.

Baker, L. Ada, ...	Amherst.
Bates, Ethel W., ...	Webster.
Beals, Mrs. J. I., ...	Sunderland.
Blakeman, Florence L., ...	Brockton.
Blodgett, Emma M., ...	Springfield.
Boland, Albert M., ...	Worcester.
Bond, Lawrence A., ...	North Adams.
Bowers, Frank H., Jr., ...	Mansfield.
Bowles, Mary N., ...	Middlebury, Vt.
Braley, Laura E., ...	Putney, Vt.
Buckler, Gertrude M., ...	Springfield.
Burt, Dorothy L., ...	Easthampton.
Cady, Howard M., ...	South Shaftsbury, Vt.
Camp, Emily B., ...	Norwich, Conn.
Campagna, S. Louise, ...	Randolph.
Carlson, C. J. Allan, ...	Cambridge.
Carpenter, Alta J., ...	Orange.
Carpenter, Ruth T., ...	North Adams.
Caruthers, John T., ...	Nashville, Tenn.
Cavanaugh, Mrs. Agnes H., ...	Springfield.
Chapin, Frederick C., ...	Greenfield.
Chapin, Marion, ...	Sheffield.
Chenoweth, Mrs. W. W., ...	North Amherst.
Colburn, Minnie A., ...	Hollis, N. H.
Cole, Rosalie M., ...	Waltham.
Collins, Anna L., ...	Hudson.
Collis, Ada E., ...	Enfield.
Corey, Mrs. Eva M., ...	Raynham Center.
Coyle, Agnes, ...	Pittsfield.
Crawford, Marion H. C., ...	Waverley.
Cristman, Clyde E., ...	Florence.
Crossley, Mrs. Jessie P., ...	Holyoke.
Crowell, Homer M., ...	Nutley, N. J.
Crozier, Ruth C., ...	Lyonsville.
Dana, Minnie L., ...	Amherst.
Darling, Eleanor, ...	Sunderland.
Derrah, Mrs. Cecilia A., ...	Andover.
Dickson, Christine, ...	Wellesley.
Dutton, Alice L., ...	Glover, Vt.
Elder, Mrs. E. A., ...	Amherst.
Emerson, Dorothy, ...	Lynn.
Esty, Pearl, ...	Richford, Vt.
Fairchild, Katharine H., ...	Sunderland.
Fairman, Louise, ...	Amherst.
Fallis, E. Hazel, ...	West Somerville.
Farley, Alice J., ...	East Boston.
Farnham, Dorothy W., ...	Needham.
Fearing, Mrs. Henry D., ...	Amherst.
Fentem, Mrs. Alice E., ...	Montague.
Fentem, Beth, ...	Montague.
Fish, Mrs. Charles, ...	Amherst.
Foley, Dora C., ...	Enfield.
Follette, Miriam A., ...	Great Barrington.
Foord, Mrs. James A., ...	Amherst.
Ford, Harold L., ...	Greenfield.
Fowler, Maude A., ...	Heuniker, N. H.
French, Fannie F., ...	Quincy.
Fusfeld, Irving S., ...	Washington, D. C.
Garlick, Lillian, ...	South Ashburnham.
Gaylord, Mrs. E. W., ...	Lititz, Pa.
Glazier, Leta, ...	Amherst.
Gleason, Gertrude E., ...	Newton Highlands.
Glowinski, Mrs. Helen, ...	Holyoke.
Gould, Warren H., ...	Buckland.

Goward, Carlotta,	Framingham.
Graves, Mrs. Lillian,	Sunderland.
Greene, Jessie M.,	Marlborough.
Greenwood, Helen E.,	Worcester.
Groeziuger, Christian,	Amherst.
Hale, C. Ethel,	Lowell.
Hamblett, Florence,	Attleboro.
Hamblett, Marion S.,	Attleboro.
Hamlin, Margaret,	Amherst.
Hammond, Lucy M.,	Northfield.
Hannaford, F. L.,	Hathorne.
Harrington, Mary L. V.,	Fall River.
Harris, Esther L.,	Dedham.
Haskins, Mora P.,	North Adams.
Hathaway, Wilfred A.,	Saugus.
Hennessey, Laura,	Fall River.
Hersey, Albert D.,	Cambridge.
Heyne, Frank A.,	South Hadley Falls.
Higgins, Mary E.,	Northampton.
Hildick, Dorothy E.,	Leominster.
Hill, Miriam,	Methuen.
Hinkley, Elsie M.,	Whitman.
Hirshberg, Elliott W.,	Allston.
Hodge, Josephine C.,	Amesbury.
Hollis, Mildred H.,	Amherst.
Holmes, May A.,	Sheffield.
Howe, Mrs. Jenabelle D.,	Amherst.
Hoves, Flora E.,	Shelburne Falls.
Hubbard, Mrs. Orpha E.,	Sunderland.
Hull, Marguerite S.,	Sunderland.
Humeston, Mrs. L. R.,	Holyoke.
Irwin, Carolyn A.,	Brookfield.
Jensen, Anna C.,	Granby.
Johnson, Edith H.,	Andover.
Johnson, Mrs. Myrtle I.,	Amherst.
Joyce, Helen M.,	Framingham.
Keane, Mary E. A.,	Boston.
Kelley, Mrs. J. E.,	Amherst.
Kendrick, Grace S.,	Shelburne Falls.
Kendrick, Ruth W.,	Brockton.
Kingsbury, May O.,	Bardwells Ferry.
Kingsley, Evelyn,	North Amherst.
Krout, Mrs. Webster,	Amherst.
Lamson, May J.,	Rochdale.
Lang, Ella F.,	Bradford.
Lang, Florence A.,	Bradford.
Larsen, Anna M.,	Orange.
Latchford, Mary E.,	Worcester.
Leban, Cecile,	Pleasantville, N. Y.
Lee, Edith M.,	Amherst.
Liden, John,	Brookline.
Lindsey, Mrs. J. B.,	Amherst.
Little, Florence L.,	Cliftondale.
Livermore, Mrs. Olive D.,	Amherst.
Loomis, Charles W.,	North Dana.
Martin, Margaret A.,	Amherst.
Mathews, Etta M.,	Worcester.
McBride, James J.,	Waverley.
McBride, John P.,	Waverley.
McLean, William A.,	Medford.
McManus, Jeannette M.,	Lynn.
McNulty, Mrs. Nellie A.,	Boston.
Meacham, Caroline E.,	Holyoke.
Miller, Helen M.,	Hadley.

Mills, Mrs. J. K.,	Amherst.
Mitchell, Edward A.,	Cappahosic, Va.
Mollan, Isabella M.,	Brookline.
Monahan, May C.,	Shelburne Falls.
Montague, Mrs. E. J.,	Amherst.
Monteith, Agnes M.,	Natick.
Morse, Fred W., Jr.,	Amherst.
Moynihan, Anna M.,	Holliston.
Mulligan, Louise E.,	Salem.
Newlon, Mrs. J. B.,	Amherst.
Nielsen, Charlotte M.,	East Boston.
Nowlan, Elizabeth T.,	Amherst.
Nugent, Gertrude V.,	East Boston.
Nutting, Rena L.,	Three Rivers.
Oberholtzer, Mrs. Rosa A.,	Sioux City, Ia.
Ogden, Lillian,	Williamsburg.
O'Neil, Patrick J.,	Rosindale.
Paige, Mrs. Ada M.,	Amherst.
Parker, Ruby,	Northampton.
Parkes, Charles R.,	New York, N. Y.
Penney, Elsie L.,	Northampton.
Percy, Myrtle L.,	Ashfield.
Perrins, William A., Jr.,	Brookline.
Perrins, Mrs. William A., Jr.,	Brookline.
Phelan, Mrs. John,	Amherst.
Prince, Walter E.,	Amherst.
Putney, Lucretia,	Brockton.
Quimby, Cora M.,	Amherst.
Rabbette, Eliza M.,	Hudson.
Ransom, Clara,	Winchester.
Rhoades, Dorothy F.,	Williamsburg.
Richards, Mrs. Viola F.,	South Deerfield.
Richmond, Sarah B.,	Buckland.
Ricks, Mrs. L. E.,	Amherst.
Ricks, W. Edward,	Amherst.
Robinson, Edith C.,	East Taunton.
Roe, Charlotte E.,	Fall River.
Rogers, Mrs. G. Edwin,	Amherst.
Root, Chester A.,	West Roxbury.
Root, George W.,	West Roxbury.
Roraback, Evelyn A.,	Sheffield.
Rorstrom, Hans A.,	Framingham Center.
Rose, Elizabeth J.,	Chicopee.
Sander, Margaret F. J.,	Cambridge.
Schedin, Mrs. Elsie,	Philadelphia, Pa.
Schoenfield, Roslyn L.,	Newton Center.
Sears, Mabel H.,	Worcester.
Sears, Mrs. Ruth S.,	Amherst.
Shears, Dorothy,	Sheffield.
Sheehan, Helen,	Northampton.
Sisson, Rachel N.,	Mill River.
Smith, Mrs. Abby H.,	Sunderland.
Smith, Ann,	Amherst.
Smith, Daisy B.,	Amherst.
Smith, Emily D.,	Amherst.
Smith, Jane,	Amherst.
Smith, Olive E.,	Norwich, Conn.
Smith, Raymond L.,	East Hartford, Conn.
Snow, Mrs. Sarah,	Cochituate.
Sparrow, Marion C.,	East Orleans.
Sprague, Eleanor,	Amherst.
Sprague, Mrs. R. J.,	Amherst.
Stephenson, Charles L.,	Windham.
Stiles, Robert M.,	Danvers.

Stowell, Harold T.,	Amherst.
Stratton, Alice I.,	Framingham.
Stratton, Ever L.,	Springfield.
Sullivan, Mrs. Annie N.,	Holyoke.
Sullivan, Mary D.,	Fall River.
Sullivan, Mrs. P. C.,	Indian Orchard.
Sullivan, Phyllis,	Indian Orchard.
Swanston, Ernest E.,	Amherst.
Swanston, Mrs. Marie,	Amherst.
Tabor, Flora A.,	Hampstead, N. H.
Taylor, Mrs. Katherine G.,	Amherst.
Thomas, Genevieve M.,	Wellesley.
Thomas, Stafford F.,	Amherst.
Thomas, Mrs. Stafford F.,	Amherst.
Thomson, Mrs. A. S.,	South Deerfield.
Thomson, Gilbert B.,	Amherst.
Tierney, Mary G.,	Holyoke.
Turner, Mary W.,	Foxborough.
Tuxbury, Grace M.,	Brockton.
Walker, Mrs. Alta M.,	Lexington.
Walsh, Mrs. Bertha H.,	Amherst.
Ward, Sarah N.,	Amherst.
Warner, Mrs. A. C.,	Sunderland.
Warren, Helen,	Grafton.
Waugh, Mrs. Frank A.,	Amherst.
Wells, Sarah A.,	Shelburne Falls.
Wheaton, Harvey H.,	Springfield.
White, Helena,	Amherst.
White, Mildred W.,	Amherst.
Whitney, Mrs. Harrie L.,	Somerville.
Williams, Dorothy B.,	Sunderland.
Williams, Mildred B.,	Harwich.
Wilson, Gustavus O.,	Cambridge.
Wood, Marion O.,	Cambridge.
Worthen, Doris M.,	Concord, N. H.
Worthley, Mrs. Ruth S.,	Amherst.
Wright, Dorothy H.,	Manteno, Ill.
Wyman, Francis,	Winchester.

SUMMARY OF SHORT COURSES.

	Men.	Women.	Total.
Two-year Course, 1919, winter term, ¹	31	6	37
Ten Weeks' Course, 1919, ¹	43	20	63
First Six Weeks' Course, 1919, ¹	13	-	13
Second Six Weeks' Course, 1919,	9	1	10
Vocational Poultry Course, March to June, 1919,	6	-	6
Summer School, 1919,	46	192	238
Summer Course for Federal Men, 1919,	31	-	31
Two-year Course, 1919-20,	201	8	209
Vocational Poultry Course, 1919-20,	13	-	13
Rural Engineering Course, 1919-20,	16	-	16
Total,	409	227	636
Counted twice,	46	-	46
	363	227	590

¹ Names published in catalogue for May, 1919.

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PUBLIC DOCUMENT

No. 31

MASSACHUSETTS
AGRICULTURAL COLLEGE

ANNUAL REPORT

OF

THE MASSACHUSETTS AGRICULTURAL
EXPERIMENT STATION

PARTS I AND II



1919

MASSACHUSETTS AGRICULTURAL COLLEGE

THIRTY-SECOND ANNUAL REPORT OF THE
MASSACHUSETTS AGRICULTURAL
EXPERIMENT STATION

PARTS I AND II



PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

THIRTY-SECOND ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL EXPERIMENT STATION

PART I

REPORT OF THE DIRECTOR AND OTHER OFFICERS

PART II

DETAILED REPORT OF THE EXPERIMENT STATION

BEING PARTS III AND IV OF THE FIFTY-SEVENTH ANNUAL REPORT OF
THE MASSACHUSETTS AGRICULTURAL COLLEGE

A RECORD OF THE THIRTY-SEVENTH YEAR FROM THE FOUNDING OF THE STATE AGRICUL-
TURAL EXPERIMENT STATION

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Massachusetts Agricultural Experiment Station.

OFFICERS AND STAFF.

COMMITTEE.

Trustees.

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	WILFRID WHEELER, ¹	. Concord.
	EDMUND MORTIMER, .	. Grafton.
	ARTHUR G. POLLARD, .	. Lowell.
	HAROLD L. FROST, .	. Arlington.
	ARTHUR W. GILBERT, ²	. West Brookfield.

The President of the College, *ex officio*.

The Director of the Station, *ex officio*.

STATION STAFF.

Administration.

FRED W. MORSE, M.Sc., *Acting Director*.

JOSEPH B. LINDSEY, Ph.D., *Vice-Director*.

FRED C. KENNEY, *Treasurer*.

CHARLES R. GREEN, B.Agr., *Librarian*.

Mrs. LUCIA G. CHURCH, *Clerk*.

Miss F. ETHEL FELTON, A.B., *Clerk*.

Agricultural Economics.

ALEXANDER E. CANCE, Ph.D., *In Charge of Department*.

Agriculture.

WILLIAM P. BROOKS, Ph.D., *Consulting Agriculturist*.

HENRY J. FRANKLIN, Ph.D., *In Charge of Cranberry Investigations (East Wareham)*.

EDWIN F. GASKILL, B.Sc., *Assistant Agriculturist*.

ROBERT L. COFFIN, *Assistant*.

Botany.

A. VINCENT OSMUN, M.Sc., *Botanist*.

GEORGE H. CHAPMAN, Ph.D., *Research Physiologist*.

PAUL J. ANDERSON, Ph.D., *Associate Plant Pathologist*.

ORTON L. CLARK, B.Sc., *Assistant Plant Physiologist*.

WEBSTER S. KROUT, M.A., *Field Pathologist*.

Mrs. S. W. WHEELER, B.Sc., ³ *Curator*.

Miss MARGUERITE G. ICKIS, M.A., ⁴ *Curator*.

ALYN S. BALL, *Assistant*.

Miss ELLEN L. WELCH, A.B., *Clerk*.

¹ Term expired Nov. 30, 1919.

² Succeeded Wilfrid Wheeler Dec. 1, 1919.

³ Resigned Sept. 30, 1919.

⁴ Appointed Oct. 3, 1919.

Entomology.

HENRY T. FERNALD, Ph.D., *Entomologist*.
 ARTHUR I. BOURNE, A.B., *Assistant Entomologist*.
 Miss BRIDIE E. O'DONNELL, *Clerk*.

Horticulture.

FRANK A. WAUGH, M.Sc.,¹ *Horticulturist*.
 FRED C. SEARS, M.Sc., *Pomologist*.
 JACOB K. SHAW, Ph.D.,² *Research Pomologist*.
 HAROLD F. TOMPSON, B.Sc., *Market Gardener*.
 WALTER W. CHENOWETH, M.Sc.,³ *In Charge of Horticultural Manufactures*.
 Miss ETHELYN STREETER, *Clerk*.

Meteorology.

JOHN E. OSTRANDER, A.M., C.E., *Meteorologist*.

Microbiology.

CHARLES E. MARSHALL, Ph.D., *In Charge of Department*.
 ARAO ITANO, Ph.D., *Assistant Professor of Microbiology*.

Plant and Animal Chemistry.

JOSEPH B. LINDSEY, Ph.D., *Chemist*.
 EDWARD B. HOLLAND, Ph.D., *Associate Chemist in Charge (Research Division)*.
 FRED W. MORSE, M.Sc., *Research Chemist*.
 HENRI D. HASKINS, M.Sc., *Chemist in Charge (Fertilizer Division)*.
 PHILIP H. SMITH, M.Sc., *Chemist in Charge (Feed and Dairy Division)*.
 LEWELL S. WALKER, B.Sc., *Assistant Chemist*.
 CARLETON P. JONES, M.Sc., *Assistant Chemist*.
 CARLOS L. BEALS, M.Sc., *Assistant Chemist*.
 JOHN B. SMITH, B.Sc.,⁴ *Assistant Chemist*.
 ROBERT S. SCULL, B.Sc.,⁵ *Assistant Chemist*.
 HAROLD B. PIERCE, B.Sc.,⁶ *Assistant Chemist*.
 Miss ESTHER S. MIXER, B.A.,⁷ *Assistant Chemist*.
 ARTHUR M. CLARKE, A.B.,⁸ *Assistant Chemist*.
 Miss ANNE C. MESSER, B.A.,⁹ *Assistant Chemist*.
 Miss ETHEL BRADLEY, B.A.,¹⁰ *Assistant Chemist*.
 JAMES T. HOWARD, *Inspector*.
 HARRY L. ALLEN, *Assistant in Laboratory*.
 JAMES R. ALCOCK, *Assistant in Animal Nutrition*.
 Miss ALICE M. HOWARD,¹¹ *Clerk*.
 Miss REBECCA L. MELLOR, *Clerk*.
 Miss CORA B. GROVER,¹² *Clerk*.

¹ Reinstated Sept. 1, 1919, after leave on account of war service.

² Resigned Oct. 31, 1919.

³ Appointed Oct. 10, 1919.

⁴ Reinstated Feb. 3, 1919, after leave on account of war service. Resigned August 15.

⁵ On leave on account of war service. Resigned Dec. 13, 1919.

⁶ Resigned Oct. 15, 1919.

⁷ Resigned Sept. 26, 1919.

⁸ Appointed Sept. 1, 1919.

⁹ Appointed Nov. 3, 1919.

¹⁰ Appointed Dec. 1, 1919.

¹¹ Resigned May 31, 1919.

¹² Transferred from Extension Service May 26, 1919.

- Poultry Husbandry.** JOHN C. GRAHAM, B.Sc.,¹ *In Charge of Department.*
LOYAL F. PAYNE, B.Sc.,² *Acting Head of Department.*
HUBERT D. GOODALE, Ph.D., *Research Biologist.*
MRS. NETTIE A. GILMORE,³ *Clerk.*
MISS RUBY SANBORN, *Clerk.*
MISS DORIS TOWER,⁴ *Clerk.*
- Veterinary Science.** JAMES B. PAIGE, B.Sc., D.V.S., *Veterinarian.*
G. EDWARD GAGE, Ph.D.,⁵ *Associate Professor of Animal Pathology.*
JOHN B. LENTZ, V.M.D.,⁶ *Assistant.*
THOMAS G. HULL, Ph.D.,⁷ *Assistant.*
-

¹ On leave of absence from April 1, 1919.

² Acting head of department during Professor Graham's absence.

³ Resigned April 21, 1919.

⁴ Transferred from college department, April 1, 1919.

⁵ Reinstated September 4 after leave on account of war service.

⁶ On leave on account of war service. Resigned Sept. 18, 1919.

⁷ Appointed September 16, temporarily.

REPORT OF THE DIRECTOR.

FRED W. MORSE, ACTING DIRECTOR.

It has been gratifying throughout the past year to note the extent to which the experiment station is regarded as the institution for the investigation and solution of agricultural problems. Requests for the investigation of definite problems have come from several distinct lines of agriculture during the period.

The county farm bureaus are united in the opinion that more investigations of spray materials and their use are required. The various brands put on the market, of both insecticides and fungicides, although complying fully with the Federal laws governing their sale, yet have such widely different directions for dilution of the concentrated pastes or the dry powders, with resultant variations in the actual strengths of the spray mixtures, that it is difficult to judge whether a given brand is good or poor. The efficiency of different concentrations of insecticides and fungicides needs to be thoroughly established.

Climatic conditions affect some of the spray mixtures or the plants to which they are applied, so that mixtures which are safe in one section or at one time cause foliage injuries at other times or in other places. This forms another problem which needs study.

The swine breeders have asked for a comprehensive study of the use of garbage in feeding pigs, which to meet fully would need a substation for swine husbandry in the vicinity of our large cities. The problem is a really important one because the statistics obtained by the Commissioner of Animal Industry show that more than half the swine in the State are fed garbage, and the industry is based mainly on the utilization of household and farm wastes.

Practical experience has shown important seasonal variations in the character of household garbage, but no definite data of composition are available. Little or no use is made of any grain with garbage, and the growth of the animals is slow, especially during the early months when rapid growth is most profitable and desirable. This problem is one which the station should be enabled to meet as soon as possible.

Some manufacturers of mixed rations for live stock have expressed a desire to furnish funds for the study of some of their brands of cattle foods. This presents a delicate matter for the consideration of the experiment station. The institution is charged by our public statutes with the inspection of feeding stuffs, which particularly includes all proprietary brands of mixed feeds and all by-products used as feeds; therefore, it cannot accept a retainer from any manufacturer or group of manufacturers to investigate a particular line of feeding stuffs the results of which will be used for advertising purposes. On the other hand, a scientific investigation of the feeding qualities of a by-product, and combinations of it with other materials, will be of great service to the farmers, and promote the sales of manufacturers, who may well afford to endow such investigations.

Heads of departments of the experiment station have pointed out some new problems that need to be solved when means can be provided. It is of interest to consider what undertaking new problems and new lines of work means to an institution organized as an experiment station. If a new problem can be studied by some members of the staff with the equipment at hand, which is frequently the case with projects arising within the experiment station, the problem may have to wait until some other work is completed, but can readily be commenced at almost any convenient time. Some problems presented to the station for its consideration require both new workers and new apparatus because the solution of them requires special knowledge and special tools. A serious difficulty, then, faces the experiment station. Additions to its income must be secured with which to employ the new workers and to purchase the required equipment. Members of the staff cannot justly be discharged nor apparatus economically

scrapped in order to take up new lines of work. The manufacturer of shoes cannot change to rubbers, nor the dairy farmer become a market gardener, without serious loss of capital due to the change.

The high costs of supplies, equipment and labor have affected the experiment station as they have all other lines of human endeavor. It is of interest to have recorded some of the changes in cost that have occurred over a period of less than a decade.

The year 1911 has been chosen as the base of comparison because in that year the appropriation from the Federal treasury reached a fixed point from which it has not changed, and this appropriation is an important part of the income of the experiment station.

Chemicals, represented by the common acids and ammonia, have advanced as follows, as shown by our invoices: sulfuric acid, from 5 cents per pound to 8 cents; hydrochloric acid, from $5\frac{1}{2}$ to 16 cents; nitric acid, from $7\frac{1}{2}$ to 14 cents; and ammonia, from $7\frac{1}{2}$ to 28 cents. Most other chemicals necessarily advanced proportionally.

Fertilizers advanced in like manner: acid phosphate cost \$12.16 per ton in 1911, and advanced to \$26 in 1919; tankage increased from \$37 to \$94 per ton; and sulfate of ammonia, from \$68 to \$128. Nitrate of soda and potash salts are not mentioned in this list because their prices last year were all the market would bear during the season, if they were obtainable.

Feeding stuffs soared fully as high as fertilizers. Corn meal averaged \$24 per ton in 1911, and cost \$67.50 last year. Cottonseed meal rose from \$30 to \$67, gluten feed from \$26 to \$64, and wheat bran from \$26 to \$47.

The laborer on the farm received \$1.75 per day in 1911 and averaged \$3 the past year.

Apparatus and tools advanced proportionally to the increases in supplies and labor.

During the same period the salaries of the members of the staff have advanced much less proportionally, except in a few cases of young workers who have been promoted. Assistants with technical training, just from college, require about 60

per cent more salary than was paid in 1911 to secure them. Men and women with the technical training required in the work of an agricultural experiment station are continually in demand in the industrial and business world, where better salaries are paid than can be paid here. This situation causes much loss of time in filling positions vacated by workers who have secured better positions elsewhere. It also renders almost impossible the development of any new lines of research that require additions to the staff of specialists.

One possible method of securing specialists for definite problems is that of making attractive fellowships for post-graduate students. The particular object of such a plan would be the employment of a specialist during the investigation of the problem, after which the worker would seek a position elsewhere as a result of the training received during his fellowship.

Four resignations were tendered during the year because of tempting offers from other agricultural colleges and experiment stations; three were from the department of chemistry and one from the department of horticulture. Dr. J. K. Shaw, research pomologist, accepted the position of head of the department of horticulture in the University of West Virginia, which was a well-deserved opportunity which could not be equaled here. He has been identified with this experiment station for twelve years, and numerous publications of the station bear witness to the quality of his work. Up to the end of the year it has not been possible to fill the vacancy.

In filling the vacancies in the department of chemistry it was found necessary to follow the plan of employing promising but less experienced workers as the only available means of keeping up the work.

PUBLICATIONS ISSUED DURING 1919.

Annual Report.

Thirty-first annual report: —

Part I. Report of the Director and Other Officers; 61 pages.

Part II. Detailed Report of the Experiment Station; 274 pages (being Bulletins Nos. 182-188).

Combined Contents and Index, Parts I and II; 12 pages.

Bulletins.

- No. 189. The European Corn Borer and its Control, by Stuart C. Vinal and D. J. Caffrey; 71 pages.
- No. 190. The Propagation of Apple Trees on their Own Roots, by J. K. Shaw; 23 pages.
- No. 191. Practical Results from Studies on Egg Production, by H. D. Goodale; 7 pages.
- No. 192. Seventh Report of the Cranberry Substation, by H. J. Franklin; 36 pages.
- No. 193. Supply and Distribution of Connecticut Valley Cigar Leaf Tobacco, by Samuel H. DeVault and Alexander E. Cance; 88 pages.
- No. 194. A Fertilizer Experiment with Asparagus, by W. P. Brooks and F. W. Morse; 27 pages.
- Special Bulletin, November, 1919. Compilations of Analyses, by J. B. Lindsey, H. D. Haskins, P. H. Smith and C. L. Beals; 101 pages.

Bulletins, Control Series.

- No. 11. Inspection of Commercial Feedstuffs, by P. H. Smith and E. S. Mixer; 32 pages.
- No. 12. Inspection of Commercial Fertilizers, by H. D. Haskins, L. S. Walker and J. B. Smith; 77 pages.

Meteorological Reports.

Nos. 361-372, inclusive, 4 pages each.

In some of the departments the important experiments are of a continuing character, and consist of cumulative data which do not permit any statements of results until definite stages have been reached; hence, there are no detailed reports submitted by these departments this year. Their important lines of work are here briefly mentioned for completeness of this report, together with certain needs and opportunities for further usefulness.

The department of agricultural economics has been unable to fill the vacancy produced at the beginning of the war because the demand for trained workers in economics has been far greater than the supply, and the opportunities for statisticians and economists in the industries and in public work are increasing rather than lessening. The work of the depart-

ment has consequently been limited to some minor problems in marketing and in farm ownership in which data could be gathered by students and temporary assistants.

There are numerous problems in agricultural economics which should be investigated as soon as the means of the station will permit.

In the department of agriculture the field experiments with fertilizers and crops were rearranged at the beginning of the growing season, and it seems unnecessary to print a detailed report until another year's results have been secured. An important development in this field is the demand for definite information about the efficiency of various natural sources of fertility, such as pulverized minerals, peat and various forms of bacteria, which are being promoted by interested parties with somewhat extravagant statements of results obtained by their use.

The important projects of the department of horticulture with apples and peaches progressed favorably. A section of horticultural manufactures was instituted late in the year, but must await additional appropriations before any extended investigations can be conducted. There are exceptional opportunities for expansion in horticulture, as shown by the following statement submitted by Professor Waugh: —

Extensive work in the manufacture of fruit products ought to be taken up at once. The need of work in these lines is very great and very pressing.

Several lines in floriculture ought to be put under way. We have really never done much of anything for the florists. The new and drastic regulations with regard to plant importations have very seriously upset their business. Extensive experiments in the propagation of plants and in the substitutions of new varieties for old will be necessary in making their readjustment. We ought to be at work on this immediately.

Additional experimental work in lines of market gardening should be taken up at the earliest opportunity.

A project is already on file for experimental work in pomology to be carried on in eastern Massachusetts.

Meteorological records are continuous and become more and more useful each year as dependence on them is getting to be common by the public. Lawsuits and damage claims are frequently influenced by the positive facts regarding weather

conditions which are obtained from our records. As adjuncts to our crop and soil experiments the records are indispensable.

Professor Ostrander makes the following statement about the need of replacements: —

Some of our meteorological instruments have been in use for more than thirty years and should be replaced, notably the wind-pressure instrument and the Draper barometer. It is recommended that a replacement fund of \$200 per year be made available for three years, so that the instruments may be renewed where necessary.

In this connection attention is called to the settlement of the tower where the instruments are installed, which is more than 2 inches and very uneven. It is suggested that in planning new buildings for the campus some building be provided with a suitable tower, so that the meteorological work may be moved to better constructed quarters.

The detailed reports of the other departments of the experiment station and of the treasurer follow.

REPORT OF THE TREASURER.

ANNUAL REPORT

OF FRED C. KENNEY, TREASURER OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE, FOR THE YEAR ENDING JUNE 30, 1919.

United States Appropriations, 1918-19.

	Hatch Fund.	Adams Fund.
<i>Dr.</i>		
To receipts from the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1919, under acts of Congress approved March 2, 1887, and March 16, 1906,	\$15,000 00	\$15,000 00
<i>Cr.</i>		
Adams: —		
By salaries, ...	\$13,088 31	
labor, ...	687 01	
chemicals and laboratory supplies, ...	225 38	
seeds, plants and sundry supplies, ...	129 55	
fertilizers, ...	115 20	
feeding stuffs, ...	201 25	
scientific apparatus and specimens, ...	553 30	
	\$15,000 00	15,000 00
Hatch: —		
By salaries, ...	\$13,631 68	
labor, ...	915 26	
publications, ...	80 50	
chemical and laboratory supplies, ...	20 59	
fertilizers, ...	203 65	
feeding stuffs, ...	6 30	
furniture and fixtures, ...	1 20	
scientific apparatus and specimens, ...	120 82	
contingent expenses, ...	20 00	
	\$15,000 00	15,000 00

State Appropriation, 1918-19.

Cash balance brought forward from last fiscal year,	\$22,934 92
Cash received from State Treasurer,	37,789 82
fees,	3,072 48
sales,	15,931 64
miscellaneous,	3,751 73
	\$83,480 59
Cash paid for salaries,	\$23,124 31
labor,	22,301 84
publications,	565 80
postage and stationery,	1,197 51
freight and express,	429 20
heat, light, water and power,	399 26
chemicals and laboratory supplies,	1,445 46
seeds, plants and sundry supplies,	3,162 65
fertilizer,	1,065 48
feeding stuffs,	2,629 17
library,	426 47
tools, machinery and appliances,	390 68
furniture and fixtures,	152 24
scientific apparatus and specimens,	155 20
live stock,	132 00
traveling expenses,	2,407 79
contingent expenses,	-
buildings and land,	1,502 91
Balance,	21,992 62
Total,	\$83,480 59

DEPARTMENT OF BOTANY.

A. VINCENT OSMUN.

During the last year the work of the department has been concerned largely with research problems, previously outlined, and with miscellaneous activities more or less routine. While no research projects have been completed, several have progressed sufficiently to make advisable the early publication of results. The amount of research work under way has not warranted the starting of any new projects during the year. There are, however, many important problems pressing for attention, and some of these are referred to later in this report.

A brief report of progress on projects follows.

In the investigation of lettuce drop, a fungous disease caused by *Sclerotinia libertiana*, a very satisfactory method of control has been worked out, and a bulletin on the subject is in course of preparation. Some of the more technical phases of this work will be discussed in a scientific paper to be published elsewhere. The project will be continued for a time.

Mr. Krout has now carried his celery spraying experiments through three seasons. The data obtained from plots in Amherst, Arlington and at the field station in Concord, with our recommendations, will be ready for publication before another growing season. The results have been satisfactory.

Investigation under the project on onion diseases has been devoted largely to smut, caused by *Urocystis cepulæ*, although miscellaneous data on other diseases have been collected. Plots for the study of control measures for smut were established in two fields, and extensive studies have been carried on in the laboratory and greenhouse throughout the year. While striking results were obtained, a more satisfactory method of control than those thus far employed is sought, and the work will continue.

Dr. Chapman's tobacco investigations have gone forward in a satisfactory manner. A report of this work up to the season of 1919 has been prepared and presented for publication as a bulletin.

In Mr. Clark's study of optimum light requirements of plants, important data have accumulated. In the field comparative studies were continued on yield, size and reproduction under different light intensities provided by the tents mentioned in our last annual report. In the laboratory further studies were made on the reaction between chlorophyll content of leaves and the light intensity under which they developed.

Weather conditions during the growing season of 1919 favored the development of many plant diseases, and the early season conditions were such as to retard and injure vegetation. Low temperatures, accompanied by high winds late in April, were fatal to peach blossoms which had blown, but few unopened buds were injured. The percentage of injury was so small that material reduction of the crop did not result. Japanese plums suffered more severely than peaches. Other fruits did not sustain noticeable injury. An abnormally wet May was responsible for much loss to vegetable garden crops, especially from stem and root rots caused by certain soil fungi. Fusarium stem rot of peas was prevalent throughout the State, and the crop was greatly reduced by it. Instances of total loss were not uncommon. Similar diseases of beans, caused by a Fusarium and Rhizoctonia, were equally destructive. Potatoes suffered severely from rotting off of the young sprouts by Rhizoctonia.

Throughout the summer instances of dying back of shrubs and trees came to our attention. This condition was not confined to any particular period, but its initial outward appearance occurred on different plants from the time leaf buds began to open until the close of the season. In the majority of cases no fungous or other parasites were present. After careful study of the situation it became apparent that the trouble could be traced back to moderate injury from the severe winter conditions of 1917-18. As pointed out in our last annual report, many trees and shrubs thus injured, but not killed outright, were unable to recuperate, owing to the

unfavorable growing conditions of the summer of 1918. Others were able to make more or less top growth, even under the adverse conditions which prevailed. Apparently, root development in the dry soil did not go on apace with growth above ground, and consequently the balance between roots and top was destroyed, resulting in dying back of twigs and branches the following (1919) season. It is not unlikely that a small amount of this resultant trouble may appear next summer.

The condition of the potato crop was in marked contrast to that which prevailed in 1918. Mosaic disease, so widespread and severe the previous year, was extremely difficult to detect in most fields, although close examination usually showed it to be present. There is marked seasonal influence on the appearance of this disease, and, apparently, conditions in 1919 did not favor the extreme development evident in 1918. Leaf roll was much more in evidence, and spindling sprout considerably reduced production, especially where home-grown "seed" were planted.

Efforts were made to follow up the accumulated evidence in regard to the parasitism of *Phoma* on potatoes, but no *bona fide* cases of the disease caused by this fungus were found, and attempts to produce it by artificial inoculation were only partially successful. This supports the opinion expressed in our last report that the weather is a prime contributing factor in the parasitism of this *Phoma*, and that under normal seasonal conditions the disease will not prove of consequence.

The condition of the potato crop up to the latter part of August was generally good. However, the period from the 18th of that month until the time of harvesting the crop was one of relatively low temperatures, high humidity and frequent rainfall, — conditions highly favorable to the development of late blight. The disease appeared in many sections of the State soon after the middle of August. From that time on it developed rapidly, and few fields escaped severe injury. A few heavily sprayed fields remained green to the end. But, as a rule, spraying with Bordeaux mixture only partially controlled the disease. These failures should not cause growers to condemn spraying with Bordeaux mixture as a practice, for it is definitely known that blight is very largely controlled by

it, except possibly under extraordinary conditions. Furthermore, it is not altogether unlikely that the majority of failures may have been due to lack of thoroughness and an insufficient number of applications. However, the season's experience, together with accumulated evidence from previous years, indicates that there is need of investigation to determine whether there are better methods and better fungicidal materials to use in combating these and other potato diseases.

The damage to orchard fruits due to diseases brought on largely by the weather conditions of the season was very heavy as compared with that of average years. On plums and peaches, brown rot, caused by *Sclerotinia cinerea*; on peaches, scab, caused by *Cladosporium carpophilum*; on apple, black rot, caused by *Physalospora cydoniæ*, bitter rot, caused by *Glomerella rufomaculans*, and scab, caused by *Venturia inæqualis*, were especially severe. Fire blight of pear, apple and quince was more than usually prevalent.

The serious outbreak of such diseases and the partial failure of potato spraying bring to the fore the question of control measures. No important experimental work on the control of orchard and potato diseases has ever been carried on in this State. Growers are following recommendations based very largely on such work done in other States. Results have not always been satisfactory, and this was true to a greater measure than usual under the last seasonal conditions. There is also lack of uniformity in results obtained from commercial spraying of these crops in different sections of the State. Growers and county agricultural agents are now more than ever before turning to the experiment station for help in these matters. The station should be able to make very definite recommendations backed by its own experimental evidence. Such work would involve technical investigations in the laboratory and field spraying under Massachusetts conditions. Until such work is done we shall not be in a position to state authoritatively what methods or materials should be used.

These are important, pressing problems, — problems vital to Massachusetts agriculture. Immediate steps should be taken to establish investigational work along these lines. Money

and men are essential. Either the growers or the State, or both, should provide them without further delay.

Other important lines of investigation which should be undertaken by this department include a study of various diseases of market-garden crops and their control; studies of soil fungi associated with "damping off," and stem and root rots of many agricultural plants; and methods of soil sterilization for the control of a considerable number of diseases the causal organisms of which are harbored in the soil.

Seed work and plant disease diagnosis required about the usual amount of attention. As has been pointed out in previous reports, all seed work is voluntary on the part of the station, as there is no State law to provide for inspection and regulation of the seed trade. Enactment of such a law, requiring the station to carry out its provisions, would necessitate increased quarters and the purchase of special equipment. It is, however, by no means certain that there is urgent need of a seed law in this State.

The filing of the mycological collection was completed by the purchase of two additional steel cases. This is now a fine working herbarium, and it is doubtful if it is excelled in accessibility of material by any other collection.

DEPARTMENT OF CHEMISTRY.

J. B. LINDSEY.

Each year it has seemed wise to make a brief statement of the work in progress, usually under the following headings:—

1. RESEARCH SECTION.

The study of the composition of butter fat, as affected by food, breed, period of lactation and other factors, has been continued under rather adverse conditions, due to changes in staff which have necessitated several months of preliminary training, with corresponding loss of time.

The butter fat from two grade Holsteins and from two grade Jersey cows on the same ration was examined during the early, intermediate and late periods of lactation. During the present season the butter fat of four grade Holstein cows, divided into two groups, is being studied. The first group receives a basal ration, and the second a basal ration with the addition of coconut fat, peanut oil, corn oil and soy bean oil.

Numerous American dyes are being examined with a view to securing an indicator applicable to the analysis of dark-colored oils and fats and those containing aldehydes, for which purpose phenolphthalein is poorly adapted.

Additional work on insecticides, in co-operation with the department of entomology, has been reported. The products studied were dry calcium arsenate, dry magnesium arsenate and dry lime-sulfur. A new Bordeaux-lead and several samples of lime-sulfur have been tested. Numerous samples were examined in cases of suspected arsenical poisoning, and two lots of pears for residual arsenic from spraying.

A description of the Massachusetts bomb calorimeter was published in the "Chemical and Metallurgical Engineering" of August, 1919.

The work of the previous year on cranberries has been continued and brought to a conclusion by the preparation of two papers, one on the chemical changes that occur in the fruit while in storage, and the other on the rate of respiration of cranberries at different temperatures. These papers were read at the annual meeting of the American Chemical Society, and are now embodied in the manuscript for a station bulletin.

In the pursuit of the investigation of the soil of the plots of Field A, which receive sulfate of ammonia, it was found that the conditions of 1910 and 1911 were repeating themselves, apparently because of the dry weather during May and June. Where lime had not been applied, positive quantities of soluble salts of manganese were found, corn plants were stunted and showed noticeable reactions for manganese in their ash, and clover and grass seed either would not germinate or died soon after germination, leaving a barren surface. Where lime had been applied, whether six years previously or this spring, no trace of soluble manganese salt was found and no noticeable injury to vegetation was observed.

Mr. Jones has done much work on apple jelly in co-operation with the department of horticultural manufactures. His work has developed the need for a thorough study of the physico-chemical properties of fruit jelly, and the relations to each other of the acid, pectin, sugar and water, before jelly making can become anything more than an empirical process.

A second experiment has been completed on the protein requirement of growing calves, in co-operation with the agricultural committee of the Council of National Defense. It was begun in January, 1919, and completed in July. Eight grade Holstein calves were divided into two groups of four each, and fed on a high and low protein diet. The minimum protein ration was somewhat higher than that fed the preceding year. Digestion experiments were made from time to time as the experiment progressed, which included the nitrogen balance. In this trial both groups made substantially the same average growth. This work was in charge of Mr. C. L. Beals, who

gave it careful attention and brought it to a satisfactory conclusion.

During the winter months digestion and metabolizable energy experiments were continued with horses. A number of by-products were tested, and several experiments for the preceding year were repeated. When the results of trials with two horses do not agree, it is advisable to repeat the experiment in order to make sure of the results.

Digestion trials with the aid of sheep were conducted on a number of proprietary grain mixtures, on oat feed and oat hulls, and repeated tests with carrots.

One experiment has been completed on cows with velvet bean feed, and another with oat feed.

Two experiments with lactic acid as an aid in promoting growth in pigs have been completed. While lactic acid when fed in small amounts (not exceeding .8 per cent in the slop) may serve as an appetizer in some cases, its use in the experiments conducted by us was negative in character.

The results of all our experiments with velvet bean feed and with lactic acid have been prepared for publication.

Observations with forage crops were continued. Sweet clover gave a satisfactory yield at the first cutting in June, but failed to recover afterwards. During four years we have only succeeded once in getting a growth after the first cutting. As was remarked last year, we fail to see any use for this crop under conditions ordinarily prevailing in Massachusetts, excepting its use in some cases as a soil renovator.

The yield of Sudan grass was light, owing to the poor catch. This has now happened for two successive years. In our judgment barnyard millet is a surer crop and is to be preferred.

The yield of dry matter on plots planted to corn, and to corn and soy beans grown together, has been determined, and this experiment, together with other data relative to corn and soy beans, has been prepared for publication.

2. FERTILIZER SECTION.

The work of the fertilizer section may be summarized as follows:—

(a) Fertilizers registered.

During the season of 1919, 101 manufacturers, importers and dealers have secured certificates for the sale of 468 brands of fertilizer, fertilizing materials and agricultural limes. They may be classed as follows: —

Complete fertilizers, ...	143
Ammoniated superphosphates, ...	174
Ground bone, tankage and dry ground fish, ...	48
Wood ashes, ...	4
Chemicals and organic nitrogen compounds, ...	71
Agricultural limes, ...	28
	468

(b) Fertilizers collected and analyzed.

During the year 7,237 tons of fertilizer were sampled, necessitating the sampling of 14,889 sacks; 153 towns were visited; 1,029 samples, representing 418 distinct brands, were drawn from stock found in the possession of 369 different agents or owners; 616 analyses were made in the year's inspection. The materials inspected, as well as the number of analyses made, are given in the following table: —

	Analyses.	Brands.
Complete fertilizers, ...	151	121
Ammoniated superphosphates, ...	201	162
Superphosphate and potash, ...	2	2
Ground bone, tankage and dry ground fish, ...	62	42
Nitrogen compounds, ...	90	32
Phosphoric acid and potash compounds, ...	42	31
Wood ashes, ...	39	4
Lime compounds, ...	28	24
Ground rock, ...	1	1

(c) Fertilizer Tonnage.

In accordance with chapter 220, General Acts of 1918, a declaration of the tonnage of fertilizers sold in Massachusetts has been made. From these data we find that from July 1,

1918, to July 1, 1919, this amounted to a total of 54,878 tons, divided as follows: —

	Tons.
Mixed fertilizers, ...	42,689
Unmixed materials, ...	12,189

Full details regarding the fertilizer inspection work may be found in Bulletin No. 12, Control Series, published in October, 1919.

(*d*) *Other Activities of the Fertilizer Section.*

In addition to the work incidental to the fertilizer control, a great variety of by-products having more or less value as fertilizers have been analyzed, and the best methods of balancing and utilizing these products have been furnished to the parties interested.

The usual number of soil samples has also been tested for their lime absorption capacity and organic matter, and advice has been furnished as to the best treatment of the soils with lime and fertilizer for the crops to be grown.

During November, December, January, February and March much co-operative chemical work was done on the problems of the agricultural department of the experiment station. The above work may be summarized as follows: —

Dry matter determinations on 15 samples of hard flint corn.
 Dry matter determinations on 15 samples of cob of hard flint corn.
 Dry matter determinations on 15 samples of soft flint corn.
 Dry matter determinations on 15 samples of cob of soft flint corn.
 Dry matter determinations on 15 samples of corn stover.
 Dry matter determinations on 6 samples of carrots.
 Dry matter determinations on 6 samples of carrot tops.
 Dry matter determinations on 4 samples of turnips.
 Weights and dry matter determinations on 290 samples of millet seed.
 Weights and dry matter determinations on 290 samples of millet straw.
 Nitrogen tests on 123 samples of millet seed and straw.
 Potash tests on 62 samples of millet seed and straw.
 Phosphoric acid tests on 12 samples of millet seed and straw.

In addition to the above tests, 347 different substances have been received and analyzed for farmers and the various departments of the experiment station. They may be grouped as follows: —

Fertilizers and fertilizer by-products, ...	157
Mixed feeds, ...	41
Lime products, ...	7
Soils for lime absorption capacity and organic matter tests, ...	137
Soils for complete analyses, ...	5
Total, ...	347

(e) *Vegetation Tests.*

Pot experiments (24 pots with millet as crop) have been conducted with bacterized peat, to show the crop-producing power of treated peat with and without bacteria. A comparison of the two peat mixtures was also made by chemical investigation in the laboratory.

Two field experiments were also made on the peat mixtures, one comprising eight plots with tomatoes, and the other eight plots with potatoes.

Two field experiments were also made to study the availability of the phosphoric acid in apatite and barium sulfide (Barium-Phosphate). One experiment with potatoes, situated north of the chemical laboratory, comprised fifteen plots, and was a continuation of the apatite experiment of the preceding year. The other was a first-year experiment laid out on the Tillson Farm, comprising thirty-eight plots, with potatoes as a crop. This experiment will be continued for a number of years.

In addition to the above, a tile experiment was run with dwarf Essex rape as a crop, forty-six tiles being employed. Apatite and barium sulfide were under study in this experiment, soil being used which was known to be deficient in available phosphoric acid. The results of the above will be reported in a later publication.

3. FEED AND DAIRY SECTION.

Work of the feed and dairy section has been continued along the following lines: —

(a) *The Feeding-stuffs Law (Acts and Resolves for 1912, Chapter 527).*

During the past year 1,084 samples of feeding stuffs were collected of dealers, and the results reported in Bulletin No. 11, Control Series. One hundred and thirty-six dealers located in 116 towns were visited at least once. One thousand four hundred and ninety-six brands of feeding stuffs were registered for sale.

There were no prosecutions for violations of the law except such as were referred to the United States Department of Agriculture under the authority of the pure food and drugs act. With the aid of the Federal officers one car of low-grade cottonseed meal was seized, and a number of other cases are now in their hands pending settlement.

National prohibition has affected the feedstuff situation to some extent, but not so seriously as its opponents would have us believe. While distillers' and brewers' by-products have been practically out of the market, the limited output being largely absorbed by manufacturers of prepared rations, it has been possible for the dairy farmer to secure other products in sufficient variety to make satisfactory rations, and at a price usually lower than that asked for proprietary mixtures.

Prices have ruled high for all feeding stuffs, but with a range so great between different commodities that the feeder has never before had a better opportunity, through intelligent judgment in their purchase, to effect large savings in the cost of necessary grain.

(b) *The Dairy Law (Acts and Resolves for 1912, Chapter 218).*

(1) *Examination for Certificates.*—Twenty-four applicants have been examined and found proficient.

(2) *Inspection of Glassware.*—Five thousand two hundred and twenty-eight pieces of Babcock glassware have been tested for accuracy, of which only 3 were condemned.

Following is a summary for the last nineteen years:—

YEAR.	Number of Pieces tested.	Number of Pieces condemned.	Percentage condemned.
1901, ...	5,041	291	5.77
1902, ...	2,344	56	2.40
1903, ...	2,240	57	2.54
1904, ...	2,026	200	9.87
1905, ...	1,665	197	11.83
1906, ...	2,457	763	31.05
1907, ...	3,082	204	6.62
1908, ...	2,713	33	1.22
1909, ...	4,071	43	1.06
1910, ...	4,047	41	1.01
1911, ...	4,466	12	.27
1912, ...	6,056	27	.45
1913, ...	6,394	34	.53
1914, ...	6,336	18	.28
1915, ...	4,956	4	.08
1916, ...	5,184	5	.10
1917, ...	7,522	8	.11
1918, ...	3,120	10	.32
1919, ...	5,228	3	.06
Totals, ...	78,948	2,006	2.54

(3) *Inspection of Machines and Apparatus.* — During the months of November and December Mr. J. T. Howard, the authorized deputy, inspected the machines and apparatus in 89 milk depots, creameries and milk inspectors' laboratories. Two machines were condemned, and minor repairs ordered in three others.

Following is a list of creameries, milk depots and milk inspectors' laboratories visited in 1919: —

Creameries.

LOCATION.	Name.	Manager or Proprietor.
1. Amherst, ...	Amherst, ...	R. W. Pease, proprietor.
2. Ashfield, ...	Ashfield Co-operative, . .	Wm. Hunter, manager.
3. Cummington, ...	Cummington Co-operative, .	D. C. Morey, manager.
4. Easthampton, ...	Easthampton Co-operative Milk Association.	W. N. Gaylord, manager.
5. Monterey, ...	Berkshire Hills Co-operative, .	F. A. Campbell, manager.
6. Northfield, ...	Northfield Co-operative, . .	C. C. Stearns, manager.
7. Shelburne, ...	Shelburne Co-operative, . .	W. C. Webber, manager.

Milk Depots.

Arlington, ...	David Buttrick.
Boston, ...	Oak Grove Farm. Plymouth Creamery Company.
Brockton, ...	Producers Dairy Company.
Cambridge, ...	C. Brigham & Son.
Charlestown, ...	H. P. Hood & Sons. H. P. Hood & Sons No. 2. Rockingham Milk Company. Turner Center Dairying Association. D. Whiting & Sons.
Conway, ...	H. P. Hood & Sons.
Dorchester, ...	Elm Farm Milk Company.
East Watertown, ...	Lyndonville Creamery Association.
Everett, ...	Frank E. Boyd. Hampden Creamery Company.
Forest Hills, ...	H. P. Hood & Sons.
Greenfield, ...	Greenfield Dairy Company.
Jamaica Plain, ...	Sterling Farm Milk Company. Westwood Farm Milk Company.
Lawrence, ...	Jersey Ice Cream Company. Turner Center Dairying Association. Willardale Creamery.
North Egremont, ...	Willowbrook Dairy.
Sheffield, ...	Willowbrook Dairy.
Shelburne Falls, ...	H. P. Hood & Sons.
Southborough, ...	Deerfoot Farms.
Somerville, ...	Acton Farms Milk Company.
Springfield, ...	Tait Brothers.
Waltham, ...	Manhattan Creamery.
West Lynn, ...	H. P. Hood & Sons.
West Somerville, ...	Francis S. Cummings.

Milk Inspectors and Laboratories.

Adams, ...	A. G. Potter.
Amesbury, ...	J. L. Stewart.
Amherst, ...	P. H. Smith.
Arlington, ...	A. W. Lombard.
Attleboro, ...	C. J. Guild.
Barnstable, ...	G. T. Mecarta.
Boston, ...	J. O. Jordan.
Brockton, ...	G. E. Bolling.
Cambridge, ...	W. A. Noonan.
Chelsea, ...	W. S. Walkley.
Chicopee, ...	C. J. O'Brien.
Clinton, ...	G. L. Chace.
Dedham, ...	E. Knobel.
Everett, ...	E. C. Colby.
Fall River, ...	H. Boisseau.
Fitchburg, ...	J. F. Bresnahan.
Framingham, ...	F. S. Dodson.
Gardner, ...	H. O. Knight.
Greenfield, ...	G. P. Moore.
Haverhill, ...	J. A. Ruel.
Holyoke, ...	D. Hartnett.
Lawrence, ...	J. H. Tobin.
Leominster, ...	W. H. Dodge.
Lowell, ...	M. Marster.
Lynn, ...	E. S. O'Keefe.
Malden, ...	J. A. Sanford.
Millbury, ...	F. A. Watkins.
New Bedford, ...	H. B. Hamilton.
Newton, ...	A. C. Hudson.
North Adams, ...	J. H. Foley.
Northampton, ...	G. R. Turner.
North Easton, ...	T. Glover.
Norwood, ...	J. J. Mulvehill.
Pittsfield, ...	A. L. Stone.
Plainville, ...	J. J. Eiden.
Plymouth, ...	W. E. Briggs.
Revere, ...	J. E. Lamb.
Salem, ...	J. J. McGrath.
Somerville, ...	H. E. Bowman.
South Hadley, ...	G. F. Beaudreau.
Springfield, ...	S. C. Downs.
Taunton, ...	L. C. Tucker.
Waltham, ...	G. D. Affleck.
Ware, ...	F. E. Marsh.

Wellesley,	.	.	.	.	W. A. Berger.
Westfield,	.	.	.	.	H. F. Moody.
Winchendon,	.	.	.	.	P. E. Phillips.
Woburn,	.	.	.	.	W. C. Mendum.
Worcester,	.	.	.	.	G. L. Berg.

Miscellaneous.

Boston,	.	.	.	.	Walker-Gordon Laboratory.
					Boston Laboratories, Inc.

(c) Water.

Sixty samples of water from farm wells and other private supplies were received and examined.

(d) Testing of Pure-bred Cows for Advanced Registry.

Four men have been given regular employment in conducting yearly tests on Guernseys, Jerseys, Ayrshires, Shorthorns and Holstein-Friesians. These were supplemented by other men as occasion demanded, there being not less than six men employed for at least part time during each month of the year. This work requires the presence of a supervisor at each farm for at least two days of each month. At the beginning of the year 45 farms had cows on test, the number gradually increasing until 60 farms were visited in December, an increase of about 33 per cent. Detailed information relative to this work can be obtained by application to the pure-bred cattle associations.

A summary of the work for the year follows: —

Summary of Cow Test Work, December, 1918, to November, 1919.

Months.	Number of Super- visors, Whole or Part Time.	NUMBER OF COWS TESTED.					NUMBER OF HERDS VISITED.						
		Guernsey.	Jersey.	Ayrshire.	Short- horn.	Holstein.	Total.	Guernsey.	Jersey.	Ayrshire.	Short- horn.	Holstein.	Total.
December, . .	8	123	79	60	-	20	282	25	8	9	-	3	45
January, . .	6	117	73	62	-	21	273	26	8	8	-	4	46
February, . .	6	123	82	68	-	23	296	27	10	8	-	4	49
March, . . .	8	146	91	73	-	20	330	27	10	9	-	4	50
April, . . .	6	146	106	75	-	23	350	27	11	9	-	4	51
May, . . .	7	131	112	77	-	21	341	25	11	9	-	4	49
June, . . .	10	153	110	83	-	24	370	27	11	9	-	4	51
July, . . .	9	155	114	85	-	24	378	27	11	9	-	4	51
August, . . .	6	153	113	65	7	25	363	29	10	9	1	4	53
September, . .	7	146	117	73	7	26	369	29	11	8	1	4	53
October, . . .	7	161	131	75	-	30	397	31	12	9	-	4	56
November, . .	8	156	133	81	4	27	401	32	12	10	2	4	60
Totals, . . .	-	1,710	1,261	877	18	284	4,150	-	-	-	-	-	614

In addition to the preceding work tests of seven, fourteen and thirty days' duration were conducted for the Holstein-Friesian Association. Owing to the increased difficulty of obtaining men on short notice, as is often desired in this kind of work, and to the impossibility of guaranteeing the men permanent employment, the experiment station has been unable to supply men to fill all applications made during the past year. It is hoped that the Holstein-Friesian Association will abandon this type of test and conduct the more valuable yearly work in uniformity with other breeds.

During the year 29 supervisors were employed at 35 different farms, and 162 seven-day, 71 thirty-day, 16 fourteen-day and 5 sixty-day tests were made and reported.

(e) *Other Work.*

This section has co-operated in making analyses of some 260 samples used in connection with feeding and digestion experiments, and has analyzed for farmers and other residents of the State, in addition to the work already stated, 498 samples of milk, 442 of cream, 7 of vinegar and 231 of feedstuffs.

NUMERICAL SUMMARY OF GENERAL LABORATORY WORK,
DECEMBER, 1918, TO DECEMBER, 1919.

There have been received and analyzed in whole or in part 60 samples of water, 498 of milk, 442 of cream, 1 of evaporated milk, 1 of human milk, 231 of feedstuffs, 157 samples of fertilizer and fertilizer by-products, ash analyses of 41 cattle feeds, 7 lime products, 137 soils for lime, a complete analysis of 5 soils, 3 arsenic determinations, 7 samples of vinegar and 7 samples of insecticides.

There were analyzed 616 samples of fertilizers and 1,084 samples of feed in connection with the regular inspections. Samples analyzed in connection with experiments in progress by the several departments of the station included 139 samples of milk, 22 of feedstuffs, 49 of fæces, 25 of urine, as well as dry matter determinations on 91 samples of crops, weights and dry matter on 580 samples, nitrogen on 123 samples, and phosphoric acid on 12 samples. The above totals 4,338 samples, and does not include work done on single research problems, cow-testing work, or that performed under the dairy law.

DEPARTMENT OF ENTOMOLOGY.

H. T. FERNALD AND A. I. BOURNE.

The following summary of the work of the department of entomology during 1919 is herewith presented.

The resignation, the 1st of May, of Mr. Quincy S. Lowry, United States Extension Service Agent in Massachusetts, left a large amount of extension work to be carried on by the department. Correspondence amounting to between 2,000 and 3,000 letters during the year was of this nature, and as it frequently happens that no diagnosis of the cause of the injury complained of is immediately possible without further details, several letters are often needed before advice can safely be given.

In many cases all the information obtainable by correspondence fails to result in recognition of the pest. Persons asking for assistance frequently realize this difficulty, and urge personal visits and an examination on the spot, and this is becoming more frequent each year. Such visits have proved to be more satisfactory and also more efficient than letter writing, as would naturally be expected, and when they can be accompanied by a demonstration of the right way to prepare and apply the proper control measures, the highest degree of helpfulness is attained. Unfortunately, absences from town interfere seriously with the experimental work of the station, for which its staff is engaged, so such assistance is given less frequently than should be the case.

During the growing season of our crops — June to September — many people, instead of writing, make personal visits to the office or use the telephone, long-distance calls being very frequent. This was so much the case during 1919 as to call for the almost constant presence of one man at the office

during business hours each day, thus preventing him from carrying on the experimental work necessary during that period of the year. The summer farmers' week also consumed much time, when it was needed and really belonged elsewhere, so that the actual station work has suffered severely.

In addition, there is a large and increasing demand for the fumigation of rooms, and even entire houses, for the destruction of household pests. This is work which is so dangerous, because of the poisonous gas used, that it should never be done except by those having had experience, and for that reason treatments of this nature have been made by members of the department. Still, it subtracts from the time available for the regular station work.

In spite of the interferences above indicated some work has been accomplished. A part of the correspondence has shown that unknown insects were causing injury, and also that old pests were working in new ways, and the investigation of such cases is legitimate station work. Examples of this are: several instances where the European corn borer was reported as working far outside its known limits of infestation; and the outbreak of the green clover worm (*Plathypena scabra* Fab.) on beans, which seemed to call for the immediate testing of various methods of control.

Potato Spraying Experiments.—As the tests made in 1918 showed a distinct superiority in results when the 4-4-50 home-made Bordeaux mixture was used, and as this substance was only incidental to the real tests which were on insecticides rather than fungicides, only homemade Bordeaux was used this year, while the arsenates of lead, of calcium and of magnesium were tested in combination with it. All of these arsenicals were commercial brands in the form of a dry powder. The arsenate of lead contained 33 per cent arsenic oxid, the arsenate of calcium about 46 per cent and the arsenate of magnesium 32 to 33 per cent. The quantity used in each case was that given by the manufacturer for potato spraying, and was such as to provide about an equal amount of poison per gallon of spray for each of the three kinds.

As far as ease of preparation was concerned, no difference between the three materials was observed, nor was there any perceptible difference in the health, vigor or rate of growth

of the potatoes in the different plots. Satisfactory protection from insects was also obtained with all three of the arsenicals, which appeared to act with about equal rapidity, and no foliage injury followed the use of either spray. Indeed, the three materials appeared to be equally good in every way except as to suspension quality and cost.

As regards suspension, the arsenate of calcium settled toward the bottom of the spray tank the most rapidly; the magnesium arsenate was a little slower in this regard; while the lead arsenate remained unsettled much longer than the others. This is a point definitely in favor of the lead arsenate, unless the pump used is equipped with a thoroughly effective agitator, when it becomes of less importance. As regards expense of these materials, based on average quotations for 1919, the cost of 50 gallons of spray for the lead arsenate used was 66 cents; for the magnesium arsenate, 50 cents; and for the calcium arsenate, 45 cents.

These tests, so far as they go, would seem to favor the use of calcium arsenate as being equally effective with the other materials, and costing less. Other facts must be considered, however. The first is that the results of one set of tests never supply information enough from which to draw safe, general conclusions. Another is that tests of calcium arsenate alone have shown that it burns foliage badly, and must be combined with considerable excess lime if this is to be prevented. In the above tests the Bordeaux mixture supplied this excess of lime. A third point is that these results were obtained with potatoes, and enough testing on other plants has been done to indicate that the results here reported may not hold at all for at least some other kinds of plants. They do indicate, however, so far as a single experiment goes, that spraying potatoes with 4-4-50 Bordeaux mixture combined with powdered arsenate of lime will give as good results as arsenate of lead or arsenate of magnesium, and at a lower cost. Whether repetitions of this experiment in other seasons and under varying weather conditions will give the same results cannot now be foretold.

Sulfoleum. — Tests of this material, which is claimed to be a miscible oil containing a considerable per cent of sulfur in solution, were made mainly to determine its effectiveness against

plant lice. Here its value would, of course, be compared with nicotine sulfate 40 per cent, which is now probably the standard material for this purpose. In recent years there have been times when it was impossible to obtain the nicotine sulfate, and a substitute easier to prepare than kerosene emulsion, available at such times, and as effective as possible, should be known, if such a material exists.

The Sulfoleum mixed readily with water, and did not separate from it on standing, even for some time. As an insecticide for plant lice it was quite effective, though not quite as much so as the nicotine sulfate. It did injure tender foliage, however; not excessively, but enough to make this a serious objection to its use.

Applied as a "cluster bud" spray to apple trees it seemed to be of some value for the control of the red bugs, and without injury in this case to the foliage.

If some change in the composition of this substance can be made by which it will be less injurious to tender foliage, without any reduction of its insecticidal value, it should become a useful material when nicotine sulfate cannot be obtained; but from the tests made last season it can hardly be recommended with its present composition. It is understood that the manufacturers are now working on it to find, if possible, a way in which it can be made safer for use while maintaining its insecticidal value.

Green Clover Worm (*Plathypena scabra* Fab.). — This insect unexpectedly became extremely abundant last summer, and caused serious injury to beans, stripping the leaves and eating into the pods, almost everywhere in the State. Its work began to be noticeable in eastern Massachusetts a little after the middle of July, and a week or so later it was evident farther west. The insect is always present in small numbers, and usually feeds on clover, but when it turns its attention, as is sometimes the case, to other legumes it becomes a pest of great importance.

When the outbreak began, an investigation was made, and it was found that most of the recommendations for control given in the literature on this insect were merely suggestions as to measures which might possibly be of value, but which in

the main had not been tested. Accordingly, experiments on control measures were at once begun.

The materials tested were repellent and insecticidal dusts, contact insecticides, and arsenical sprays and dust. The repellent and insecticidal dusts proved worthless, partly, perhaps, because of the habit of the caterpillar, when disturbed, of dropping to the ground, but mainly because it was practically impossible to cover the under surfaces of the leaves where most of them feed. Contact insecticides also failed, the plants in most cases being so closely matted together that the caterpillars could not be reached by the sprays, and when the plants were parted the insects dropped to the ground, as already stated.

Calcium arsenate, magnesium arsenate and lead arsenate were used as sprays. These poisons, sprayed onto the leaves, would be consumed by the insects when they ate through to the upper surfaces, so the poison could be sprayed onto the plants without disturbance, and left for the caterpillars to eat when they got to it. As the insects after a short time eat entirely through the leaves, this placing of the poison was effective. The calcium and magnesium arsenates burned the foliage so badly, however, that their value as insecticides was less than the injury they caused. Lead arsenate gave entire success, particularly if applied before the leaves had been badly riddled. The only drawback to its use was in cases where the pods were nearly ready for picking. In such cases the only way of handling proved to be to thoroughly wash the beans gathered after treatment, to remove the poison which had fallen on them.

Arsenate of lead powder, dusted onto the leaves, was also effective against the insects, but proved difficult to apply evenly with any of the dusting machines, and where it was too thick it injured the leaves.

Generations of the Codling Moth. — Whether the second generation of the codling moth is sufficiently important in Massachusetts to require a special late treatment has for years been a question. It now seems probable that it is not often large enough to need consideration. Uncertainty as to the best time for the second spring spraying for this pest has led

to a continuation of studies on this insect, which have already given interesting results. This investigation should and will be carried further.

Studies on our Common Scale Insects. — Work on this subject in 1918 developed new phases which promise unexpected and possibly important results as to the reaction of these insects to climatic conditions. These investigations will, therefore, be continued.

Seasonal Appearance of Pests. — Our insect pests vary in time of their arrival each year with the nature of the season. As successful treatment should begin immediately upon their appearance, if the most successful results are to be obtained, definite information on this subject is much to be desired. Work along this line has been begun, mainly incidental to other observations and taking little extra time, but the results thus far have been very suggestive, and seem to encourage a belief that valuable conclusions of direct benefit in spraying may be obtained. It is too early in this work to predict, but so far this study has indicated the possibility that people in different parts of the State can be given each year definite dates on which to give treatment, comparable with that now given for the calyx spray for the codling moth.

Tests of Standard Insecticides. — This project has now been under way for a number of years. Its scope is such, however, that final conclusions and the end of the work are not yet in sight, though certain results have already been obtained. About 2,000 different tests on this project were made last summer, and the data are now being studied. It was thought wise this year to include magnesium arsenate in the materials tested, it was being pushed so much on the market, but the results obtained thus far have been to show that it is entirely too injurious to foliage in its present form for safe use. Further tests of it will be discontinued unless it is prepared in a safer form.

Studies on Digger Wasps. — This is an Adams fund project. Investigations here have also made progress, though, as usual, less than could be desired. It is now evident that these insects have been considerably overrated in importance as parasites, their reproductive capacity, and therefore the food sup-

ply necessary, being less than was once supposed. Their range of parasitism and method of life are, however, of much interest. It is hoped that preliminary publication on this subject will not be much longer delayed.

Onion Maggot Control. — The onion maggot is often a serious pest, and further experiments along the lines indicated last year have been made. The results of these have not as yet been worked out, so that no statement of conclusions can as yet be given. The maggot was not very abundant, and results therefore may be of little value, but the applications must be made, in any case, before the insects appear when no knowledge is possible of the amount of infestation there will be.

Garden Plot. — The use of a small garden plot near the office has again been of much assistance. Many experimental tests can be made there, and demonstrations of methods of control, for those visiting the office for advice, have been possible in this way. The ordinary care of the plot has been given outside of business hours, and, in fact, much of the work outlined above has been done after the regular working hours of the day, during the summer season.

Numerous lines of investigation which would be of much benefit to residents of the State cannot be taken up under existing conditions, as we have neither the funds nor assistance with which to carry them on. One of these is the problem of the lime-sulfur wash as compared with dry sulfur compounds. Incidentally, a few tests have been made, but what is needed is a careful series of comparative experiments to determine the actual effectiveness of these materials, their ease of application and of handling, their relative cost, and to ascertain differences in results with the different materials. Hundreds, possibly thousands, of fruit growers in Massachusetts are waiting to learn whether it is advisable to change from the wash to the dry compounds, which are so much easier and cheaper to obtain if water can be left out and the material shipped to them in a dry form.

DEPARTMENT OF POULTRY HUSBANDRY.

H. D. GOODALE.

Good progress in establishing a strain of non-broody high producers has been made. Indeed, it is believed that such a strain is already in hand, but the tests necessary to substantiate this statement will require two or more years.

A theory of the inheritance of broodiness has been developed, based on the study of records extending over a period of six years and involving over 2,000 birds. Generally speaking, the fundamental hereditary basis of broodiness is alike in all birds, but upon this basis may be superimposed genetic modifiers, in addition to environmental modifying factors, which operate either to increase or decrease the amount of broodiness. Absence of broodiness is due to changes either in the fundamental basis for broodiness or to inhibitors; hence, there are probably many different genetic kinds of non-broodiness.

Daily temperature records have been kept on a series of birds, the chief interest of which lies in the discovery that a bird's temperature drops sharply at the onset of a broody period, and, if the bird is allowed to incubate eggs, returns to normal only during the latter part of the incubation period. It had commonly been supposed that the broody hen was in a febrile condition.

An attempt to use the same piece of ground two years in succession in rearing chicks proved unsatisfactory the second year. To determine the reasons for this result requires further work.

It may be of interest to report on the production of this station's high-producing line in hands other than ours. Fifty-five pullets, full sisters of the birds in our own pens, but hatched May 27, *i.e.*, after our own hatching season was completed, left our hands as day-old chicks, and were reared

in close confinement. One or two members of the flock began laying in November, but most of them did not mature till December. The average production for the flock, November 1 to October 31, was 185 eggs each, or a gross income per bird of \$9.25, with eggs at an average price of 60 cents per dozen.

Previous reports have emphasized the value of maintaining poultry under disease-free conditions, and have pointed the way toward the attainment of this condition. Facilities have been lacking to carry out our recommendations, except while the birds were on range. However, several people in the State have put this method to practical test, some of the tests extending over a period of four years, and with uniformly successful results, thus demonstrating that by starting with eggs or baby chicks, and rearing them under clean environmental circumstances, the disease problem in poultry can be controlled.

Owing to environmental circumstances beyond my control, very marked alterations in projects have been necessary which involve the practical abandonment of those phases that were being actively pursued. Other phases, not subject to unfavorable effect from the environment, will be substituted.

Inbreeding is a highly desirable method for fixing desirable traits in a strain. On the other hand, it often yields very poor results from the standpoint of vitality. Investigations of this subject might well be undertaken in a systematic manner if suitable facilities were available.

DEPARTMENT OF MICROBIOLOGY.

C. E. MARSHALL.

During the year 1919 our energies have been devoted to several topics of investigation, some of which have been pushed further than others because of circumstances and conditions.

Food. — Three years ago we undertook the study of canning, pursued it for a short time, and then had to give it up on account of financial conditions. Considerable work, however, was done in connection with heat penetration and transmission for the purpose of destroying micro-organisms in canned foods. This work was undertaken by Mr. E. G. Hood and Mr. G. B. Ray, and has not been resumed until recently. Mr. Conrad H. Lieber has been picking up the threads and pushing the work still further.

In our first efforts we also began the study of micro-organisms involved in canned goods, and especially those that are so resistant that the usual heating does not kill them. This was undertaken by Miss Louise Hompe. Miss Mary Garvey has recently taken up this work to continue it.

Dr. Arao Itano pursued the study of hydrogen ion concentration and its influence upon the destruction of micro-organisms in canned foods, and also upon the development of micro-organisms. He has published an article dealing with the scientific aspects of this theme in the *Journal of General Physiology*. He has also taken up the study of anaërobic conditions in connection with the development of micro-organisms in canned goods, and presented a paper bearing upon this theme at the recent meeting of the Society of American Bacteriologists. This work is continuing with the assistance of Miss Garvey.

There is much else to be done before we shall be able to complete our food investigations outlined three years ago, but we are doing all that is possible with the help that is available.

Dairy. — At the beginning of the academic year Mr. Roy C. Avery began the study of streptococci in milk and milk products, butter and cheese, in association with his brother, Dr. Oswald T. Avery, of the Rockefeller Institute for Medical Research, who is studying streptococci in connection with diseases. There is a wide field of investigation here which ramifies in many directions having a practical bearing. Mr. Avery can undertake only a very limited phase of the subject, but it would be well worth the attention of the experiment station to expand and continue the investigations in this field.

The De Laval studies have been continued as rapidly as has been possible under the circumstances. Prof. A. N. Julian has reported on the difference in the content of carbon dioxide in clarified and unclarified milk. Mr. Max Marshall has prepared an article, which was presented at the recent meeting of the Society of American Bacteriologists, on the association of *Bacillus subtilis* and *Streptococcus lacticus* in milk. This work pertains directly to the influence of the clarifier in disturbing the germ-equilibrium of milk. Mr. John Yesair has contributed data which indicate the influence of a centrifuge or clarifier upon different micro-organisms.

The purpose of this work as a whole is to furnish an analysis of what the clarifier does in the clarification of milk. A general résumé of this analysis has been published in the American Journal of Public Health.

Mr. R. C. Avery is also at present engaged in studying the influence of the clarifier upon the pasteurization of milk.

Besides the above work there is work under way, upon which we hope to be able to report some time, by Mr. E. G. Hood, who is studying the colonization of bacteria in milk, and by Mr. James Neill, who is studying the influence of *Streptococcus lacticus* upon certain protein changes in milk.

Soil. — Dr. Arao Itano, in connection with Mr. L. C. Whitaker, is pursuing the study of microbial changes of organic matter in the soil, confining himself at the present stage of the

work to carbon dioxide determinations. Dr. Itano is also doing a limited amount of work with peat decomposition, which is under the direction of the department of chemistry.

The analytical work of the department may be summed up as follows: —

Bacterial counts on milk samples: —

For the local board of health, ...	46
For local dealers, ...	23
For Sheffield district of Willow Brook Dairy, ...	741
Water samples tested, ...	6
Specimens submitted by town physicians, ...	120
Legume cultures distributed, ...	384
For alfalfa, ...	117
For beans, ...	24
For soy beans, ...	59
For peas, ...	61
For sweet peas, ...	2
For cow peas, ...	5
For crimson clover, ...	4
For red clover, ...	24
For alsike clover, ...	15
For white clover, ...	3
For sweet clover, ...	19
For vetch, ...	51

DEPARTMENT OF VETERINARY SCIENCE.

JAMES B. PAIGE, D.V.S.

During the past year the lines of experimental work in the department have been carried along in accordance with plans of previous years, in so far as was possible. In view of the fact that a part of the staff was absent during a portion of the time in military service, both the investigation and control lines of work suffered considerably.

Dr. J. B. Lentz, in charge of the poultry disease elimination problem, was away from July, 1917, to August, 1919. Upon his discharge from the service he decided not to return to the department, but to engage in veterinary practice in his home town in Pennsylvania. To fill the vacancy made by the retirement of Dr. Lentz, Thomas G. Hull, Ph.D., of Yale University was engaged to take charge of the poultry disease elimination work. Dr. Hull reported for service Sept. 16, 1919.

Dr. G. E. Gage, associate professor of pathology, withdrew from the department in February, 1918, for military service. He returned to resume his work at the opening of the college year in September, 1919.

POULTRY DISEASE ELIMINATION.

For three years prior to February, 1918, the agglutination test of the blood had been made for the diagnosis and elimination of bacillary white diarrhea of fowls and chicks. During that period about 35,000 birds were tested, with the most favorable results. Flocks, in which the mortality of young chicks hatched from eggs of hens infected with bacillary white diarrhea ranged as high as 75 per cent, were freed of the disease to the extent that not the loss of a chick occurred from the disease after the test had been applied and the infected birds removed from the breeding flock.

In February, 1918, owing to the enlistment of Dr. Gage in the army, it became necessary to suspend the testing for an indefinite time. This proved a great disappointment and danger to the poultrymen. The Massachusetts Poultry Society, with a membership of about 500 poultry keepers, petitioned the Legislature of 1919 for an appropriation of \$5,000 to enable the experiment station to resume the work. After the usual hearings before the committees on agriculture and ways and means, the following bill was reported, which was enacted into law and received the approval of the Governor on May 23, 1919: —

CHAPTER 185, GENERAL ACTS OF 1919.

AN ACT TO PROVIDE FOR THE TESTING OF POULTRY AND THE ELIMINATION OF DISEASE.

Be it enacted, etc., as follows:

The department of veterinary science of the experiment station at the Massachusetts Agricultural College may expend a sum not exceeding two thousand dollars out of the appropriation made for the maintenance and current expenses of the college, in item numbered four hundred and eighty-two of the general appropriation act, for the purpose of testing poultry to eliminate disease. The department is further authorized to charge a fee not exceeding seven cents for each test so made. [*Approved May 23, 1919.*]

It will be noted that the act above carries an appropriation of \$2,000, whereas the petitioners asked for one of \$5,000. This is explained as follows: When the hearings were held it was explained to the committees that it had been necessary to suspend testing because of the absence of the men overseas, who had had it in charge, and that it would not be possible to resume operations until they had, one or both, returned to the department. In addition, it was explained that poultrymen would not care to have birds tested at the time of the enactment of the bill because of the lateness of the season, when all hatching operations were over for the year. In view of these facts, and the additional one that the act could not take effect until after the expiration of ninety days following its approval, on account of its carrying an appropriation and the absence of preamble, the committee on ways and means was led to recommend an appropriation of \$2,000 to carry on the work

from August 23 to the close of the fiscal year, Nov. 30, 1919. In providing this amount for three and one-half months' work the Legislature was extremely liberal in its appropriation, exceeding by a generous sum the pro rata amount asked for by the petitioners.

In accordance with the provisions of the legislative act the necessary literature, consisting of a circular letter and application forms, was prepared in August and sent to the many poultry keepers throughout the State. The generous response to the letter was indicated by the early receipt of applications calling for the testing of nearly 15,000 birds. Since that time additional applications have brought the number up to nearly 25,000.

Mr. Oliver S. Flint, a graduate of the Massachusetts Agricultural College, class of 1917, was engaged to collect blood samples. He reported for duty on Sept. 9, 1919. After the preliminary work connected with the application of the test had been carried out, the collection of blood samples from flocks throughout the State was started, and has been continued to date. On an average 700 samples have been collected and tested each week. On account of the suspension of the work during 1918 the collection of blood samples has been somewhat difficult and expensive. It has been found that pullets that have not laid will not respond to the test; hence, it has frequently been necessary to visit a poultry farm, take samples from the adult birds, then at a later date return and procure samples from the pullets. If the work is carried along continuously from this time on, much of the labor and expense in the future will be eliminated, as each poultryman will carry over from year to year much of the stock tested the previous year.

From the date in September when the work of testing was resumed until November 30, the close of the fiscal year, there was expended in salaries, travel, express charges and equipment the sum of \$1,193.97. The receipts for the same period from tests and sale of leg bands amounted to \$401.96.

HOG CHOLERA INVESTIGATIONS.

The department continues to carry on its experiments with a herd of garbage-fed hogs kept in co-operation with a farmer in Amherst. The number of animals varies at different seasons of the year from 75 to 150. All old and young pigs are given the "simultaneous" treatment, consisting of an injection of anti-hog cholera serum and virus administered at the same time. Each successive crop of young pigs, spring and fall farrowings, has during the past two or three years been given the "single" treatment at about the age of eight weeks, this treatment consisting of the administration of about 20 cubic centimeters of anti-hog cholera serum without the virus. The immunity produced by this injection of serum continues until the animal attains a weight of about 50 pounds, when it is given the double or "simultaneous" treatment that ordinarily protects against hog cholera infection for the remainder of the life of the individual. One of the objects of study is to determine whether or not it is possible to develop a strain of hogs possessing sufficient inherited immunity so that the trouble and expense of the single treatment that is given at the weaning age may, with safety, be omitted. Other problems under investigation refer to the kind and amount of serum and virus required to produce a lasting immunity, the relation between hæmorrhagic septicæmia, necrotic enteritis, suppurative pneumonia, hog cholera, etc.

During the past year there has been some difficulty experienced in procuring the materials necessary for the conduct of the experiments connected with hog cholera.

INCOMPLETE STUDIES.

When Dr. Gage left the department in February, 1918, to enlist in the army service he had three studies relative to *Bacterium pullorum* under way. These were enumerated in the last annual report, as follows:—

1. *Bacterium pullorum* infection.
2. A comparison of the antibodies of *B. pullorum* with those of the *B. coli*-*B. typhi*-*B. dysenteræ* group of agglutinins.
3. The toxicity of *B. pullorum* products.

It is expected that during the next year some of these studies may be completed and the results published in the annual report.

NEW INVESTIGATIONS.

During the past few years the poultrymen throughout the State have had serious trouble and losses in their flocks as the result of two diseases that appear to be somewhat new to the practical poultrymen and the poultry pathologists. They are frequently found existing simultaneously in the same individual. The marked symptoms of the more common is a progressive paralysis of the extremities, coupled with a loss of flesh. The other disease affects the eyes, one or both, and invariably causes blindness.

To determine the cause of these diseases and their relations to each other, together with means of prevention or successful treatment, Dr. Gage and Dr. Hull, co-operating, have started exhaustive and systematic microscopical, bacteriological and serological investigations, which it is hoped may be productive of results that will be published in a later report.

BULLETIN No. 189.

DEPARTMENT OF ENTOMOLOGY.

THE EUROPEAN CORN BORER AND ITS CONTROL.

BY STUART C. VINAL AND D. J. CAFFREY.

FOREWORD.

During 1918 the Massachusetts Agricultural Experiment Station and the Bureau of Entomology of the United States Department of Agriculture worked on the European corn borer under a co-operative agreement by which the station was to make a study of the life history, food plants, methods of distribution and methods of control of the insect, while the Bureau was to determine its distribution, develop control measures and prevent its further spread.

Mr. Stuart C. Vinal, assistant entomologist of the experiment station, was assigned to this work on the station side, and located in Arlington. He worked day and night on the subject and accomplished an enormous amount, but with such disregard for his health that when attacked by influenza he was unable to resist it and died Sept. 27, 1918.

The person best fitted to take up and bring together for publication the information gathered by Mr. Vinal was Mr. D. J. Caffrey, who had been in charge of the Bureau side of the work, and who had been in close touch with Mr. Vinal's investigations throughout the year, and he therefore took the material left by Mr. Vinal and has brought it together and put it in shape for publication. Fortunately, most of it was already well worked out, but providing the data obtained by the United States government as its share of the work, and the form and arrangement of the whole bulletin have been Mr. Caffrey's contribution. The line drawings have been prepared by the writer of this foreword, from sketches made by Mr. R. E. Snodgrass of the United States Bureau of Entomology.

H. T. FERNALD.

INTRODUCTION.

Practically all insect pests of foreign origin found in the United States have reached our seaports through the agency of commerce. The great variety of living plants, as well as raw materials for use in manufacturing enterprises and the miscellaneous freight and personal effects that are daily received on our shores from all parts of the world, provide an ample opportunity for the entrance of almost any destructive pest. Many of these insect immigrants, on finding favorable climatic and food plant conditions, become permanently established, and in the course of time spread from their point of origin and become of more economic importance each year, unless checked by artificial agencies.

The danger existing from these involuntary importations of destructive insect pests is still further increased by the fact that in most instances their natural enemies are not imported with them. Under these circumstances the pest is enabled to extend its activities without being subject to the natural handicaps imposed by nature. This results in a more rapid multiplication and a greater degree of destructiveness than exists in the original habitat of the insect.

Such, in brief, is the history of many of our most important and generally distributed insect pests of to-day.

To the long list of foreign pests now found in the United States must be added the European corn borer, or corn pyralid, *Pyrausta nubilalis* Hübner, which has recently become established in the eastern part of Massachusetts.

The caterpillar of this insect has long been recorded in Europe and Asia as one of the most serious insect enemies of corn, hemp, millet, hops and other crops. Corn and hop plants are very severely damaged by this pest, 50 per cent of these crops often being destroyed in some sections of Central Europe.

As a result of studies made on the habits and destructive powers of the European corn borer throughout the infested portion of Massachusetts during the seasons of 1917 and 1918, it is evident that this species is without doubt the most dangerous and destructive insect enemy of the corn crop that has yet been introduced into the United States. As corn is one of the bulwarks of American agriculture, and has within the past few years become our most valuable crop from a monetary standpoint, it will be recognized that the problem of controlling this insect which threatens to destroy a large per cent of the crop each year is not confined to Massachusetts, but is a problem of national importance, which must be acted upon promptly and thoroughly to the end that the insect may be at least confined to its present area of distribution, if ultimate extermination is found to be impossible.

If this insect is allowed to extend its area of distribution and reach the corn belt of the middle western States, it will be a national calamity. Although Massachusetts is universally considered to be a manufacturing

State, it should be stated that during 1917 a total of 2,806,000 bushels of field corn were grown in the State which were worth \$6,033,000 according to the prices prevailing the 1st of the following December. This is in addition to the value of the sweet corn, fodder corn and popcorn produced in the State. Aside from the national importance of restricting the spread of this dangerous insect, the State of Massachusetts should take all measures to protect the revenue obtained from its corn crop.

There are several other species of destructive corn borers known to attack corn in the United States, the most important of which are the larger cornstalk borer, *Diatraea zeacolella* Dyar, and the lesser cornstalk borer, *Elasmopalpus lignosellus* Zeller. These two species occur in the South, and even to some extent in the northern States, but have never become permanently established in Massachusetts or any other State with a similar climate. They are doubtless unable to withstand the severe winter conditions, and this characteristic has the effect of greatly limiting their range of distribution. The European corn borer, however, is not limited in its range by ordinary climatic conditions, judging from its range of distribution in the Old World, and from its behavior to date in the infested area of Massachusetts. The species would thus be able to adapt itself to all parts of Massachusetts and ultimately to the entire country.

In Massachusetts the only native stalk borer attacking corn is *Papaipema nitela* Gn., which more frequently infests the stalks of potatoes, tomatoes and numerous common weeds. This insect, however, does not normally occur in sufficient numbers to cause serious loss. During the past two seasons, however, it has been rather more abundant than usual and because of the fact that its injuries to corn superficially resemble those caused by the European corn borer, much of the damage really caused by the latter has been attributed to the native stalk borer.

SYNONYMY.

The species was first described and figured by Jacob Hübner (2) in 1796. He described the male and female as separate species, — the male as *Pyrallis nubilalis*, and the female as *Pyrallis silacealis*. Owing to this fact the synonymy of the species in Europe is somewhat confusing.

Haworth (3) in 1811 refers to the species as *Pyrallis glabralis*.

Treitschke (4) in 1829, and Duponchel (5) in 1831, adopted the name *Pyrallis silacealis* Hübn.; although recognizing that the *Pyrallis nubilalis* of Hübner was the male of *Pyrallis silacealis* Hübn.

Guenée (7) in 1854 accepts the species as being identical with the *Botys eupulinalis* illustrated in the *Icones Insectorum* of Clerck (1) in 1759. A study of the figure referred to in Clerck's work, however, convinced later workers that it could not be the same insect. Nevertheless, this error by Guenée led to the acceptance of *Botys* as the generic name by several succeeding workers.

During the same year Guenée (8) gave the name *Botys zealis* to a species from the East Indies very close to *Botys eupulinalis*. After the description he adds this note: "It may be simply a variation of our *eupulinalis*, or, rather, this latter may have become acclimated among us with the cultivation of maize, and may be of exotic origin." In the present state of our knowledge the first theory seems to be the most probable.

Lederer (9) in 1863 retains the species in the genus *Botys*, where it had been placed through the faulty conception of Clerck's figure, by Guenée, as previously mentioned. Lederer, however, accepts the figure of Hübner's *nubilalis* as truly representing the species, and refers to it as *Botys nubilalis*. This name is accepted by Staudinger and Wocke (10) in 1871.

Moore (12) in 1888 refers to the species as *Hapalia kasmirica*. He is followed by Butler (13) as late as 1889, who designates the species as *Hapalia eupulina* (non Clerck).

Meyrick (14) in 1895 removed the species to the genus *Pyrausta*, and retained the *nubilalis* of Hübner, in which he has since been followed by Hampson (15), and by Staudinger and Rebel (17) in 1901.

We may therefore accept the species as *Pyrausta nubilalis* Hübn.

COMMON NAMES APPLIED TO SPECIES.

In Europe several different common names are applied to the species under consideration. The names most frequently used are the "corn pyralid;" "maize pyralid;" "pyralid of the maize;" "maize botys;" "botys;" "millet botys;" and "der Maiszünsler."

In the literature concerning the insect which has been published in the United States since its discovery, the species has been referred to as the European corn borer and the European cornstalk borer.

The former name undoubtedly is more appropriate for the insect, as the larvæ attack all parts of the corn plant except the fibrous roots, and do not confine their operations to the stalk as the name cornstalk borer would imply. Although many plants are attacked by the insect, corn is its favorite host, and is injured to a greater extent than any other commercial crop attacked by it. The name European is adopted to indicate its foreign origin, although the species is indigenous to other parts of the world. Taking all facts into consideration, it is believed that the name European corn borer is the most appropriate common name for the insect, and as such it will be considered in this bulletin.

FOREIGN HISTORY.

Foreign literature contains a large number of references to the serious damage caused by *P. nubilalis*, a loss of 50 per cent of the crops attacked being reported by some writers. There is, however, a decided lack of literature dealing with its biology and control. The only exceptions are the brief and incomplete articles by Robin and Laboulbène (11) in 1884,

and of Jablonowski (16) in 1899. Robin and Laboulbène detail the habits of the larvæ and the character of their damage to corn, hemp, hops and other food plants. The authors give an account of the severe damage which resulted from the attacks of this insect on corn, hemp and hops in the Department of the Aisne (France) during 1878 and 1879, as well as short extracts from the writings of other European authors mentioning the activities of this insect in various food plants. The absence of parasites is noted, and brief descriptions are given of the larva, pupa and adult. The authors recommend the burning of plants containing the overwintering larvæ, during the fall or early winter, as the most effective means of control.

Jablonowski records a very severe outbreak of *P. nubilalis* which destroyed a fourth part of the corn crop in Hungary during 1898. This damage was especially pronounced in the large plains of Hungary, which are very fertile. The author describes the character of the damage caused by the larva to corn, millet, hemp, hops and various minor food plants. The adult is described and figured very accurately; its habits of flight are detailed, and also the oviposition habits of the female. Mention is made of a single parasitic fly (*Ceromasia interrupta* Rdi.) which the author bred from the larva. Reference is also made to Kollar (6), who in 1837 recorded that some Ichneumonidæ had been bred from the species. For control measures Jablonowski recommends that early in the season, when most of the larvæ are confined to the terminal nodes of the plant, these upper portions be cut off and thrown into a water barrel, to be subsequently treated with hot water or fluid manure. This procedure can be repeated at short intervals because the treatment will not curtail the harvest. After harvest the infested plants should be pulled up by the roots and burned. In cases where the upper parts of infested plants are harvested the remaining stubble should be lightly plowed up, collected with a rake and burned. The author mentions the fact that the plowing under of infested material does not injure the contained larvæ. He also states that after shelling the corn the cobs should be used as fuel during the winter. The burning of all wild grasses that may serve as host plants for the overwintering larvæ is another general recommendation. These methods were found to be attended with considerable labor and expense, but were very effective in controlling the pest in Hungary during the outbreak of 1898.

HISTORY IN UNITED STATES (MASSACHUSETTS).

DISCOVERY OF THE INSECT.

During the summer of 1917 the senior author found many sweet corn fields in the vicinity of Boston, Mass., which were being very severely injured by light-colored larvæ which tunneled in the stalk and later attacked the ears.

Further investigation disclosed the fact that the identity of these dep-

redating larvæ was unknown to the entomologists of that section where the insect had been found. This aroused the interest of the senior author, who had early recognized the serious nature of the pest. He accordingly collected pupæ from infested cornstalks in the field during the month of July, 1917, from which the adults emerged early in August.

IDENTIFYING THE SPECIES.

To secure the identification of the species concerned, Dr. C. H. Fernald's extensive collection of both native and exotic moths was available at Amherst, Mass. An examination of his European collection revealed specimens of both male and female Pyralid moths, identical with those reared from the infested cornstalks in eastern Massachusetts. These European specimens had been determined by Mr. E. L. Ragonot, a French lepidopterist, as *Pyrausta nubilalis* Hübner.

Specimens of the moths reared in Massachusetts were also submitted to Dr. H. G. Dyar of the United States National Museum at Washington, D. C., who gave the same identification, stating that it was a common and very destructive pest of various wild and cultivated plants in the Old World.

A PREVIOUS RECORD IN MASSACHUSETTS.

Prior to 1917 this insect had never been reported as occurring in the United States, although the following supplementary facts should be recorded. During August, 1916, specimens of dahlia stems infested by lepidopterous larvæ were sent to the Massachusetts Agricultural Experiment Station from three localities near Boston, Mass. (Medford, Everett and Lynn). Adults were bred from this material, but their identity was not discovered nor their significance realized at the time. Later, however, the senior author determined these adults as being identical with the *P. nubilalis* bred from corn in 1917. Thus *P. nubilalis* was first bred in the United States in 1916, although its identity was not known until adults were bred from corn in 1917.

PRELIMINARY INVESTIGATIONS.

As soon as this pest was found to be of foreign origin, and its potential menace to American agriculture realized, its presence became of more than local importance, and a survey was made in eastern Massachusetts during the latter part of September, 1917, to roughly determine its distribution and any other pertinent facts bearing on the insect, and the results of this preliminary survey were published by the senior author (18) in December, 1917. At this time it was found that the insect had established itself in an area covering approximately 100 square miles, immediately north and northwest of Boston, Mass., and that the towns at the mouth of the Mystic River were more generally infested than the others. In this section are several cordage factories which import hemp

(*Cannabis sativa*) from Europe. This fact, together with the knowledge that hemp is one of the favorite food plants of *P. nubilalis* in Europe, at once suggested the possibility that this insect may have reached our shores through this medium. Early sweet corn grown in market gardens 10 to 12 miles inland had been seriously attacked by this pest for the past three or four years, and from this it is inferred that the species was imported about 1910, although this date is a mere conjecture. At this time (1917) sweet corn was found to be the only valuable commercial crop attacked by *P. nubilalis*, the early crop being damaged to the extent of 10 to 20 per cent, while the loss to late plantings ranged as high as 75 to 80 per cent. Several weeds and grasses were also noted as food plants of *P. nubilalis*. Observations made on the feeding habits of the species in the infested fields confirmed the original belief that the insect under consideration was possessed of characteristics that would render it a serious menace to the corn crop, and that it would be a very difficult pest to control. Burning, burying or feeding the plants containing overwintering larvæ were methods suggested for the control of the insect. It was pointed out that measures for insuring or compelling satisfactory handling of all infested material were very necessary, and that though these results might possibly be obtained by local organizations of farmers and gardeners instituting vigorous action, it seemed probable that the matter must be taken in hand by the State or Federal authorities if the insect was to be brought under control and its further spread prevented.

PLANS MADE FOR FURTHER INVESTIGATIONS.

Accordingly, Dr. H. T. Fernald, head of the Department of Entomology at the Massachusetts Agricultural Experiment Station, notified officials of the Bureau of Entomology at Washington, D. C., of the presence of the European corn borer in Massachusetts, and reviewed the facts already known as to the dangers existing from the presence of this pest. Plans were immediately made for co-operation between the Massachusetts Agricultural Experiment Station and the Bureau of Entomology, in a further investigation of the insect, in order to determine its biology and methods of possible control. Special attention was to be given to the food plants and distribution of the insect in the United States, with a view to recommending quarantine measures that would prevent the spread of the pest through avenues of commerce.

Quarters were established at Arlington, Mass., in April, 1918, and the results of the investigations to Nov. 30, 1918, are presented in this bulletin.

CONTROL MEASURES DURING SPRING OF 1918.

During the spring of 1918 a campaign was inaugurated by the Massachusetts State Board of Agriculture, which had for its object the burning of cornstalks and other infested plants within the infested towns. This work was under the direct supervision of Mr. Wilfrid Wheeler, Secretary

of the Board of Agriculture, and Mr. R. H. Allen, State Nursery Inspector. The infested towns were placarded with warning notices illustrating the insect, and recommending the burning of all cornstalks remaining from the previous year. This was supplemented by a detailed survey in each of the infested towns and the burning of cornstalks in instances where the owners failed to comply with the recommendations. The States Relations Service of the United States Department of Agriculture, through the county agricultural advisers and other agents, aided in this campaign of publicity.

CONTROL MEASURES DURING AUTUMN OF 1918.

In October, 1918, an extensive campaign was begun for the eradication of all cornstalks, weeds and crop remnants of the current season which contained the corn borer larvæ. This was under a co-operative agreement between the Massachusetts Department of Agriculture and the Bureau of Entomology, Section of Cereal and Forage Insect Investigations. Crews of men were placed in each of the infested towns, who, under the direction of competent foremen, burned infested material that had not been eliminated by property owners or their representatives. This was preceded by a similar campaign of publicity to that in force during the spring clean-up work, although on a larger scale. Town and State officials aided in this work in some instances by agreeing to destroy the infested plants growing on public property under their jurisdiction, but, owing to the early approach of severe winter weather, it is probable that the clean-up of infested plants will not be completed until the early spring of 1919.

QUARANTINE MEASURES ENACTED AND THEIR ORIGIN.

National Quarantine Measures.

In late July, 1918, it was found that many sweet corn ears exposed for sale in the wholesale markets at Boston were infested by larvæ and pupæ of the European corn borer. This circumstance at once suggested the possibility that these infested products might be shipped outside the area already infested by the insect and become sources of new infestations. As a result of reporting these facts to the Federal Horticultural Board a public hearing was held at Washington, D. C., Aug. 27, 1918, to consider a proposed quarantine of that portion of Massachusetts known to be infested by the European corn borer. At this time, however, quarantine action was deferred in order to await the results of the field conference scheduled to be held at Boston, Mass., Sept. 6, 1918, to consider ways and means of handling the problem.

This conference was attended by entomologists and agricultural authorities from all of the New England States, New York and New Jersey, and by officials of the Bureau of Entomology, the Massachusetts Market Gardeners' Association, and the Boston Produce and Fruit Exchange.

A field meeting was held in the morning, during which those attending the conference were taken to a badly infested sweet corn field at West Medford, and the injury of the insect to corn and other plants observed. In the afternoon the present status of the insect was discussed and suggestions made for its control or possible extermination. The consensus of opinion inclined very strongly to the belief that vigorous quarantine and control measures were necessary if the destructive insect was to be confined within its present limits. This course of action was favored jointly by the entomologists and by the representatives of the market gardeners and produce dealers present.

Accordingly, notice of quarantine No. 36, on account of the European Corn Borer, *Pyrausta nubilalis*, was issued by the secretary of agriculture through the Federal Horticultural Board, and became effective on and after Oct. 1, 1918. This quarantine order applied to the towns which were known to be infested by the insect, and prohibited the interstate movement, to points outside the quarantined area, of all corn fodder or cornstalks, whether used for packing or otherwise, green sweet corn, roasting ears, corn on the cob and corn cobs. No restrictions were placed on the interstate movement of any of the enumerated articles that had originated outside of the quarantined area and were shipped through it on a through bill of lading.

Further investigation will probably show the necessity for amending this quarantine order to include additional territory and other articles, plants or plant products liable to contain the insect.

State Quarantine Measures.

The Hon. Elbert S. Brigham, Commissioner of Agriculture of Vermont, learning of the dangers existing from the presence of the pest in Massachusetts, immediately sent his assistant, Mr. H. L. Bailey, to investigate the situation in the infested fields near Boston, and as a result the State of Vermont issued a quarantine notice, on account of the European corn borer, which became effective on and after Aug. 26, 1918. This quarantine prohibited the movement of all stalks or ears of the corn plant (*Zea mays*), either green or dried, from the State of Massachusetts into the State of Vermont, unless written permission be secured from the Commissioner of Agriculture of the State of Vermont. This restriction did not apply to ordinary commercial dried shelled corn used for feeding purposes, nor to any corn grown in other States and sent through Massachusetts in transit.

A similar quarantine to that by Vermont was established by the State of Connecticut, effective Sept. 20, 1918. Permits to ship corn on the ear, stover or other parts of the corn plant (except the shelled dry kernels, or cooked or preserved products, or corn grown in other States passing through the State of Massachusetts in transit) must first be obtained from the Director of the Connecticut Agricultural Experiment Station, and accompany each shipment.

GEOGRAPHICAL DISTRIBUTION.

IN THE OLD WORLD.

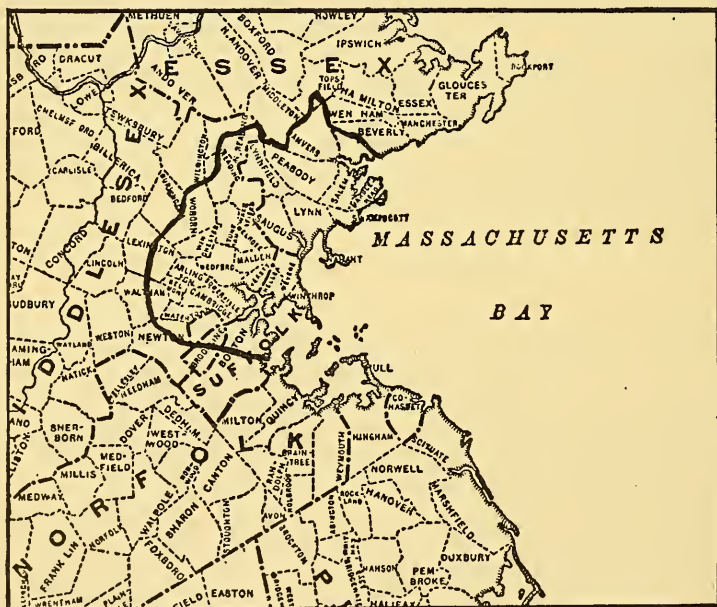
The European Corn Borer, or Corn Pyralid, *P. nubilalis* Hbn., is widely distributed in central and southern Europe, west central and northern Asia, China, Japan and the Philippine Archipelago.

Hübner, in his original record of the species, gave the habitat as Europe, western Asia, the Himalayas and Assam (British India).

A closely allied, if not, indeed, the same, species is reported from the East Indies (8).

IN THE UNITED STATES.

At the present time¹ the European corn borer, so far as is known, is found in the United States only in the counties of Suffolk, Middlesex,



Map showing area in Massachusetts infested by European corn borer, November, 1918. Heavy black line denotes limit of distribution.

Essex and Norfolk, in the State of Massachusetts. Thirty-four towns are infested, comprising an area of approximately 320 square miles, or about three times the area believed to be infested after the discovery and preliminary survey of the situation in 1917. This area is located imme-

¹ Nov. 30, 1918.

diately west and north of the city of Boston, Mass., and has as its limits the towns of Beverly, Danvers, Topsfield, Peabody, North Reading, Reading, Woburn, Lexington, Waltham, Newton, Brookline and Boston. (See map.) All the towns within these limits are infested to a greater or less degree.

Granting that the section near the mouth of the Mystic River was the original point of entrance, it will be noted that the European corn borer has shown a decided tendency to spread in a northerly and northeasterly direction. This characteristic has been exhibited by other insects introduced from Europe, notably the gypsy moth (*Porthetria dispar* L.) and the brown-tail moth (*Euproctis chrysorrhæa* L.). An examination of the meteorological records shows that during the periods when the adults of *P. nubilalis* are in flight, the prevailing winds are from the south and southwest. This may be the decisive factor in influencing the direction of the spread of *P. nubilalis*, as it is thought to be in the case of the other insects mentioned.

The area given above is believed to represent very accurately the limits of the district as yet invaded by the European corn borer. During the past season several men were engaged in determining these limits. In addition to this, the surrounding and contiguous territory in the States of Massachusetts, New Hampshire and Maine was examined for possible isolated infestations. Some other sections of these States were also examined because of the fact that their trade with infested sections near Boston might have led to the involuntary introduction of the pest in infested plant products. This was especially true of the summer hotel districts in Maine and New Hampshire, to which shipments of sweet corn were frequently made that had originated in the badly infested market-garden districts near Boston.

Territory examined in Massachusetts.

All of northeastern Massachusetts was examined to the New Hampshire line, and as far west as Tyngsborough, Westford, Acton, Sudbury, Wayland and Natick. On the south and east the territory was examined to Dover, Westwood, Canton, Randolph, Holbrook and Weymouth. Special attention was given the sections adjacent to the large cordage factories located at Andover and at Plymouth, with the idea that the pest may have been imported with hemp consigned to these factories. No infestation was found, however, outside the limits of the area previously designated.

Several reports were received during the season that the European corn borer was present in widely separated localities throughout the State. Care was taken to investigate all of these reports, but aside from those originating within the known area of infestation, it was found that insects other than *P. nubilalis* were responsible for the reported injury.

Territory examined in New Hampshire.

The entire southeastern section of New Hampshire, in addition to the summer hotel districts, was examined for evidences of the European corn borer by Mr. F. H. Gates of the Bureau of Entomology.

Particular attention was given the following localities, viz.: Portsmouth and surroundings, including New Castle; Greenland, Rye and Rye Beach; Hampton and Hampton Beach; Dover and vicinity; Rochester and vicinity; Farmington and vicinity; Concord and vicinity; Hookset; Manchester and vicinity, including Goffs Falls and Amoskeag; Derry and Londonderry; Nashua and vicinity; Pelham; Windham; Epping; and Thornton.

No evidences of the insect were found anywhere in New Hampshire.

Mr. W. A. Osgood, assistant to the deputy commissioner of agriculture of the State of New Hampshire, reports that, during October, 1918, he made a survey of the towns in the State bordering on Massachusetts, but did not find any indication of the European corn borer. Mr. Osgood had previously visited the infested fields near Boston, and had become familiar with the appearance of the pest.

Territory examined in Maine.

The following localities were examined in the State of Maine by Mr. R. H. Van Zwaluwenburg of the Bureau of Entomology for the possible presence of the European corn borer: Portland, — city and suburbs, including South Portland, Deering, Woodfords, Falmouth Foreside, Peak's Island and Great Diamond Island; Kennebunkport and Kennebunk Beach; Kittery; Wells Beach and village; Yarmouth; South Poland Springs and eastward to Danville Junction; Bath, — city and suburbs, including Woolwich; Rockland, — town and suburbs; Camden and Crescent Beach; Bar Harbor, — town and vicinity south to Newport Mountain and north to within a mile of Hull's Cove; Bangor, — city and suburbs, north to Mount Hope, south to Hampden Highlands and on east bank of the river south through Brewer to North Orrington; Augusta, — town and suburbs within a radius of 2 miles north and west, on east bank of river north to Riverside, east to Togus and south to opposite Hallowell; Hallowell; Gardiner; Lewiston, — city and suburbs; Auburn; Minot; and Mechanic Falls.

No evidences of the pest were found in the State of Maine.

During the progress of this survey Mr. Van Zwaluwenburg learned that considerable quantities of early sweet corn, originating in Massachusetts, had been shipped into Kennebunkport, Me., during the past few seasons. One retailer stated that he had recently received sweet corn, grown near Boston, that was infested with worms of some kind. The merchant had sold this shipment along with his other corn, however, and could give no testimony as to its ultimate disposal. A very careful

examination of this section failed to reveal the presence of the European corn borer. This incident, however, demonstrates that the coastal region from Portland south to York, in the State of Maine, should be very carefully watched for the appearance of the species.

Mr. John A. Roberts, Commissioner of Agriculture of Maine, reported in August that his assistants had inspected sweet corn offered for sale in the stores at Augusta, Me., and were not able to find any evidence of the borer. Similar reports were received from Mr. Dudley of the same office, and from Mr. Batchelor of the Maine Agricultural Experiment Station. These gentlemen had previously visited the infested fields near Boston, and were familiar with the appearance of the insect.

Territory examined in Rhode Island and Connecticut.

Reports were received concerning the possible presence of the European corn borer in corn at Providence, R. I., but an investigation proved that the injury was caused by *Papaipema nitela* Gn.

A similar report, received from Putnam, Conn., was investigated and also proved erroneous.

FOOD PLANTS.

IN THE OLD WORLD.

The principal food plants of the European corn borer in the Old World are corn, hemp, hops and millet. Corn (both field corn and fodder corn) and hop plants are recorded as being more severely injured by the pest than any of the other commercial crops grown in Europe.

Foreign literature also contains references to a great variety of minor food plants, including heather (14); artemisia (13); nettles (13); oak-galls (15); kidney-bean pods (15); grapevines (18); thistle (18); giant weed, *Arundo donax* (12); pigweed, *Amaranthus retroflexus* (18); fuller's teazel, *Dipsacus fullonum* (18); virgin's bower, *Clematis vitalba* (18); and several species of wild grasses and weeds.

IN THE UNITED STATES (MASSACHUSETTS).

At the present time corn (sweet corn, field corn and fodder corn) is practically the only valuable commercial crop which is seriously attacked by the European corn borer in Massachusetts, although other commercial crops are attacked by the insect to some extent.

Corn is undoubtedly the favorite food plant of the pest. In the absence of corn, and in badly infested areas, the insect habitually attacks and enters a great variety of other wild and cultivated plants. Judging from observations made on the feeding habits of the species during the seasons of 1917 and 1918, it would not be surprising to find it present in almost

any plant possessing a moderately soft, fleshy stem or stalk, or bearing a soft seed head during its early growth. Along the outer edge of the infested region, and in areas only recently invaded, the insect is almost always found exclusively in corn.

In badly infested fields the corn plants are frequently inhabited by so many feeding larvæ that all of the desirable plant tissue is quickly consumed, and under these circumstances the larvæ must leave their original host and enter other food plants growing in the vicinity in order to obtain food. Many of the eggs and smaller larvæ are sometimes dislodged from their original location on the corn plant and fall to the ground or upon other species of plants growing underneath, or between the rows of the corn, to subsequently infest these other plants. This characteristic often accounts for the great variety of infested plants found in the vicinity of badly infested corn fields.

The early season corn plants become dry and hard during July and August. Many of these plants contain belated *P. nubilalis* larvæ of the first generation, as well as small larvæ of the second. The comparatively soft tissue of late season plants growing in the vicinity often attracts the corn borer larvæ from their original food plant.

Plants other than corn, growing in areas planted to corn during the preceding year, frequently have eggs laid upon them by moths resulting from the overwintering larvæ in the crop remnants of the preceding year. In other instances the moths drift into areas where corn plants are absent, and deposit their eggs upon the most attractive food plant at hand. It is believed, however, that the moths prefer to deposit their eggs upon corn.

Another factor which is of interest in connection with selection of food plants is that the larvæ prefer large healthy plants, growing in well-fertilized land, to small plants of the same species, growing under less favorable conditions.

List of Food Plants.

The following table will show the list of food plants in which the European corn borer has been found in Massachusetts to date. This list has been compiled by dissecting the larva from each plant mentioned. Adults were reared in instances where the identity of the larva was in doubt.

The plants are arranged in order, with regard to their preference as food plants by the insect.

TABLE I. — *Food Plants of the European Corn Borer in Massachusetts.*

COMMON NAME.	Scientific Name.	Part of Plant attacked.
1. Sweet corn, ...	<i>Zea mays</i> , ...	All except root.
2. Field corn, ...	<i>Zea mays</i> , ...	All except root.
3. Fodder corn, ...	<i>Zea mays</i> , ...	All except root.
4. Barnyard grass, ...	<i>Echinochloa crus-galli</i> Beauv., .	All except root.
5. Pigweed (redroot), ...	<i>Amaranthus retroflexus</i> L., . .	Stalk and seed head.
6. Dock, ...	<i>Rumex crispus</i> L. and <i>R. obtusifolia</i> L.	All except root.
7. Ragweed (hogweed), ...	<i>Ambrosia</i> spp., ...	Stalk and seed head.
8. Lamb's-quarters, ...	<i>Chenopodium album</i> L., ...	Stalk and seed head.
9. Dahlia, ...	- - -	Stalk and flower stems.
10. Foxtail, ...	<i>Setaria glauca</i> Beauv., ...	Seed heads.
11. Lady's-thumb (smart weed),	<i>Polygonum persicaria</i> L., ...	Stalk.
12. Burdock, ...	<i>Arctium minus</i> L., ...	Stalk.
13. Horseweed, ...	<i>Erigeron canadensis</i> L., ...	Stalk.
14. Beggar-ticks (bur marigold),	<i>Bidens frondosa</i> L., ...	Stalk.
15. Purslane (pussley), ...	<i>Portulaca oleracea</i> L., ...	Stalk.
16. Crab grass, ...	<i>Digitaria sanguinalis</i> Scop., . .	Stalk.
17. Scouring rush, ...	<i>Equisetum</i> spp., ...	Stalk.
18. Panic grass, ...	<i>Panicum dichotomiflorum</i> Michx.,	Stalk.
19. Timothy, ...	<i>Phleum pratense</i> L., ...	Seed head.
20. Goldenrod, ...	<i>Solidago</i> sp. L., ...	Stalk.
21. Thistle,*	<i>Cirsium</i> spp., ...	Stalk.
22. Apple of Peru, ...	<i>Nicandra physaloides</i> L., ...	Stalk.
23. Gladiolus, ...	- - -	Stalk.
24. Chrysanthemum, ...	- - -	Stalk.
25. Celery, ...	- - -	Outside stems.
26. Swiss chard, ...	- - -	Stalk and midrib of leaves.
27. Beans, ...	- - -	Pods, green beans and the vines.
28. Potatoes, ...	- - -	Vines.
29. Tomatoes, ...	- - -	Vines.
30. Beets, ...	- - -	Tops (stem and midrib of leaves).
31. Spinach, ...	- - -	Tops (stem and midrib of leaves).
32. Oats, ...	- - -	Stalks.
33. Turnips, ...	- - -	Tops (feeding on exterior of leaf stems).

Emphasis should be placed upon the fact that the great variety of food plants attacked will undoubtedly prove a serious complication in the problem of controlling the insect.

Several of these food plants or their products, notably sweet corn (green), field corn (on the cob), celery, beet tops, beans (string beans), Swiss chard, oat straw (used as packing material), dahlias, gladioli and chrysanthemums, are commonly transported through the regular channels of trade, and may easily serve as agencies for carrying the insect into new localities.

CHARACTER AND EXTENT OF INJURY.

CORN.

The following explanation, concerning the terms herein applied to different parts of the corn plant, may be of assistance. The corn plant is monœcius, bearing both staminate (male) and pistillate (female) flowers, separate, but both occur on the same plant. The corn tassel bears the male flowers and the corn silks are the female flowers. The cornstalk consists of nodes (joints) and internodes (intermediate spaces). A single leaf grows from each node. Each leaf is composed of three distinct parts, — the sheath, the ligula and the blade. The sheath is the part of the leaf surrounding the stalk, and, beginning at a node, extends upward nearly to the next node, where it joins the long narrow blade of the leaf. Although the sheath surrounds the stalk, the edges merely overlap and are never grown together. The ligula is a thin, upward continuation of the sheath, above its junction with the blade, at the point where the sheath ends and the blade begins. The blade is the broad, flat portion of the leaf. The pedicel is that portion of the plant by which the ear is attached to the stalk. The pith is the soft, cork-like substance filling the interior of the stalk, between the internodes.

Kinds of Corn injured.

In Massachusetts the larvæ of the European corn borer have been observed to attack sweet corn, field corn and fodder corn.

In the area now infested by the insect, sweet corn is grown to a greater extent than either field corn or fodder corn, and most of the observations herein recorded were made on sweet corn.

Wherever field corn has been found within the infested area the plants have been attacked by the insect with the same degree of severity as has been sweet corn, and, due to its longer period of growth, the damage to the ears is much greater than to the ears of sweet corn.

Only one field of fodder corn was located within the infested area, and this was attacked by the insect to a slight extent. This infestation was on the edge of the infested area in the town of Topsfield, where only an occasional larva of the European corn borer was found.

Injury to the Tassel.

The newly hatched larva of the European corn borer first attacks the unopened staminate buds of the tassel. After entering and feeding upon the internal succulent parts of several staminate buds, it enters the stalk 2 or 3 inches above the lower branches of the tassel, and tunnels upward for 2 or 3 inches. It then returns to its original entrance and tunnels toward the base of the plant.

Within a few days the larva completely consumes the central pith of the tassel stalk, soon causing a break at the point where it originally entered. The broken-over portion of the tassel still remains partly attached to the plant, and in this condition its yellow-white color and broken-over position make it a very conspicuous object in a field of corn in contrast to the green color and upright position of tassels not infested.

This type of injury indirectly affects the formation of corn kernels on the cob by greatly reducing the amount of pollen. In the process of fertilization, pollen from the tassel must fertilize the corn silk in order that kernels may develop. It is apparent that if pollen is not present in large enough quantities the resulting ear of corn will show a lack of fully developed kernels. Field counts made in badly infested areas showed that as high as 61 per cent of the corn tassels had been broken over and were barren of pollen. This high percentage of injury was more common on late corn than on early corn, due, perhaps, to the greater number of larvæ present. Out of a total of 3,810 tassels, counted in a field of late season, sweet corn at West Medford, Mass., 2,344 tassels, or 61 per cent, were infested and broken over. Many ears of corn from this field were noticeably small in size and with few kernels, even though not themselves directly injured by the insect. Much of this loss is believed to have been caused by the injury to the tassel, although this belief is contrary to the opinion of botanists consulted. It is apparent that botanists must reverse their opinion in this matter.

Injury to the Stalk.

In nearly all cases the terminal internode, bearing the tassel, furnishes sufficient food for the full development of a single larva. Other larvæ, if present in the same tassel, are forced to leave and tunnel in the lower parts of the plant for food. Their operations are generally confined to the upper two-thirds of the stalk, but, if numerous, they may extend their tunneling to the very base of the stalk, or even into the upper part of the taproot. When several larvæ are feeding in the same stalk the pith is nearly, if not entirely, consumed, and the interior of such a stalk is found to be practically hollow. There is a tendency for the larvæ to work in the internodes of the stalk, but, when necessary, they commonly pierce, and feed upon, the nodes. This latter observation is contrary to published records on the habits of the species by European writers.

A total of 75 corn plants, growing in a badly infested field at West

Medford, Mass., were carefully dissected and counts made of the larvæ found therein, in order to secure data concerning the number infesting single plants. A maximum of 117 larvæ, and a minimum of 7, with an average of 46 larvæ per plant, were found in these 75 plants. These plants composed a total of 17 hills taken at random in different parts of the field. A maximum number of 311 larvæ, and a minimum of 151, with an average of 206 larvæ per hill, were found in these 17 hills of corn. The 17 hills of corn composed of 75 plants contained a total of 3,503 larvæ. The actual count of one-eighth of an acre in this field showed a total of 2,855 plants, or 22,840 plants to the acre. Each of these 2,855 plants was infested to a greater or lesser degree. An average infestation of 46 larvæ per plant, as shown above, means a total of 1,050,640 larvæ of the European corn borer per acre of corn.

Naturally, this extensive injury to the interior of the cornstalk, together with the numerous entrance and exit holes of the larvæ on the surface, weakens the plant to such an extent that it soon breaks over and lies prone upon the ground. The supply of nutriment to the ear is also cut off, causing a small or aborted ear of corn. Even when only a few larvæ are present within the plant, the growth of the stalk and formation of the ear are greatly retarded.

The tunnels left by the larvæ of the European corn borer frequently serve as sources of infection by various rots and fungi, so that the interior of badly infested stalks is sometimes found to be a mass of putrifying matter, occupied by various scavenger insects that have gained admittance to the plant by way of the entrance or exit holes of *P. nubilalis* larvæ.

Injury to the Ear.

The indirect injury to the ear by larvæ of the European corn borer has already been mentioned. This is caused (1) by interference with proper pollenization resulting from larvæ cutting off the tassel, and (2) by internal injury to the stalk, which cuts off the normal supply of nutriment to the ear.

The ear, however, is also directly injured by the external and internal feeding of the larvæ. Frequently the moths of the first generation, and habitually those of the second generation, deposit their eggs directly upon the silk of the ear. The newly hatched larvæ feed first upon the silk, thus contributing to improper fertilization, and later they work their way down into the ear, where they tunnel through all parts of the cob and also feed upon the newly formed kernels. Sometimes eggs are deposited upon the exterior, or husk, of the ear, and the newly hatched larva feeds for a time upon the exterior of the husk before entering the ear, either at its tip end, or between the edges of the leaves of the husk.

The ear is frequently entered by partly grown larvæ, which have left some other plant or another part of the same plant. These larvæ may enter the ear at any point, — its tip end, along the sides, or through the side of the pedicel. In other instances they tunnel directly from the in-

terior of the stalk through the pedicel and into the ear; consequently, the infested ears may not show external indications of injury.

A combination of these larval habits may result in the presence of several larvæ within a single ear. In one instance a total of 15 were found feeding on the interior and exterior of one ear. Extensive feeding of this nature reduces the ear to a soft, decaying condition, totally unfit for market, and unsuitable, even, for feeding to stock. This deterioration is hastened by the introduction of various rots and fungi, which gain entrance to the plant through the holes made by the borers. Even when only a single larva is present within the ear, its feeding renders the ear unfit for market, while its use for seed, or for storage in cribs, is absolutely prevented, owing to the softened condition of the kernels and their tendency to quick decay.

The percentage of ears infested in any given field depends upon the degree of infestation. An actual field count, made in a one-eighth acre plot of sweet corn located at West Medford, Mass., showed that, out of a total of 3,311 ears present in this plot, the entire number were infested, to a greater or lesser degree, by larvæ of the borer. This plot was typical of most of the fields and small garden patches of sweet corn found in the territory where the pest has become well established. It serves as a standard by which to judge the amount of damage to corn that may be expected if the pest is not brought under control.

Injury to the Leaf.

Newly hatched larvæ of the European corn borer may feed upon the upper or lower epidermis of the leaf blade before they enter the buds of the tassel. This type of injury is of no economic importance, except that it offers a possibility for poisoning the young larvæ by application of arsenicals. Partly grown larvæ infrequently tunnel into the midrib of the leaf blade, and also feed between the leaf sheath and the stalk.

Summary of Injury to Corn.

The economic injury to corn may be summarized as follows: —

1. Injury to tassel which results in poor fertilization.
2. Injury to stalk which reduces vitality of plant.
3. Injury to stalk which causes breaking over of plant.
4. Injury to stalk which indirectly affects ear.
5. Injury to ear which directly affects the yield.
6. Injury to silk of ear which results in poor fertilization.

OTHER FOOD PLANTS.

Dock.

In the absence of corn, dock is a common food plant of the first generation of European corn borer larvæ. The plant is represented by at least two different species in the area infested by *P. nubilalis*, and both species

are attacked by the insect. It grows plentifully as a weed in cultivated areas, and also in waste places, generally preferring rather moist soil.

The newly hatched borer feeds first upon the tender seed head, or upon the epidermis of the tender leaves. As the larva develops it tunnels through the leaf petiole, and when about half grown enters the main stalk. It then usually tunnels downward, feeding through nodes and internodes, and consuming in its progress nearly all the interior of the stalk. This causes a weakening of the plant which soon breaks over at the point where the larva entered. The broken-over portion soon dies and turns brown in color, thus rendering it a very conspicuous object among plants not infested. A mass of conspicuous yellowish-white frass, extruded by the larva within, generally adheres to the point in the stalk where the larva entered. This serves to distinguish plants infested by *P. nubilalis*, even in instances where the plants do not break over.

The number of dock plants per acre is generally rather limited, so that all plants of this species in a given area are commonly infested, depending, of course, upon the degree of infestation.

Economically, dock is important in that it serves as an early season host plant for the European corn borer in areas where corn is absent. The second generation adults emerging from dock deposit their eggs upon late corn and other commercial crops.

Barnyard Grass.

Barnyard grass is the most important and the most commonly infested weed among the uncultivated hosts of the European corn borer. All parts of the plant, except the root, are fed upon by the larva, including the seed head, the leaves and the stalk. Barnyard grass grows luxuriantly in almost any waste area of ground, or in the spaces between economic plants in cultivated fields. It seems to prefer well-fertilized soil, and under favorable conditions may reach a height of 5 or 6 feet, with a diameter at the base of nearly half an inch. It is very abundant in all parts of the area infested by the European corn borer, and serves as a food plant for both generations of larvæ.

The newly hatched larvæ feed for a short time upon the green buds of the seed head, and also upon the upper or lower epidermis of the leaves. They soon enter the main stalk of the plant, however, and tunnel upward or downward according to their individual preference. A dozen or more are sometimes found in each stalk, and as the stalks grow very thickly clustered together in clumps, a foot or more in diameter, the aggregate number of larvæ infesting each clump of barnyard grass often equals the number normally found in a hill of badly infested corn. Many areas of vacant land, large or small in extent, throughout the infested region, are thickly covered by barnyard grass clumps of this description, which contain untold numbers of the depredating larvæ.

Owing to the small diameter of most barnyard grass stalks, the tunneling of the larva leads to an early collapse of infested stalks, which

soon fall to the ground. This forms a mass of intertwined plants very difficult to remove or destroy during clean-up operations.

The chief economic significance of barnyard grass as a food plant of the European corn borer lies in the fact that it serves as a common host of the insect, and aids in its multiplication and distribution in areas where corn is absent.

Pigweed.

Pigweed, or redroot, is commonly found growing among cultivated crops, or closely adjacent thereto. It generally serves as a sort of overflow host plant to accommodate the larger larvæ of the corn borer which have left their original host plant and are seeking other food.

In rare instances newly hatched larvæ are found feeding upon the green seed heads of this plant. This is generally caused by the dislodgment of these larvæ from their original host.

More commonly the plant is attacked by good-sized larvæ which have partly completed their development in other food plants. The stalk is entered at any point along its surface, and the larva tunnels upward or downward in the same manner and with the same results as have been mentioned for other food plants.

Pigweed is not generally infested by the European corn borer with the same degree of severity as are dock and barnyard grass, although it is important economically as an intermediate host of the insect, and may act as a host in the absence of more favored food plants.

Ragweed and Lamb's-quarters.

Ragweed, or hogweed, and lamb's-quarters serve as food plants for the European corn borer in the same manner and extent as has been described for pigweed. The larvæ attack the green seed head and stalk of each of these plants. Lamb's-quarters sometimes grows to a height of 4 or 5 feet, and develops a tough, woody stalk an inch or more in diameter. It is perhaps the hardest and toughest stalk in which the larvæ of the European corn borer have been found.

Both ragweed and lamb's-quarters are found widely distributed throughout the infested area, although the number of plants found in a given space is generally small.

Dahlias.

Larvæ of the European corn borer tunnel through the main stalk and flower stems of dahlias during the late summer and fall. The percentage of dahlias in a given area, infested by the larvæ, is generally very high. In Arlington, and other towns adjacent to Boston, almost every group of dahlia plants was found to be infested by *P. nubilalis* during the past summer. Small larvæ are rarely found in dahlias, most of the damage being done by those which have hatched and fed for a time on other plants in the vicinity, and are about half grown when they enter the dahlia plants. Entrance may be effected at almost any place along the

main stalk or flower stem, but the favorite point is at the junction of flower stems with the main stalk. The tunneling larva soon consumes the interior of the infested stalk or stem, and that portion first wilts and then breaks over in a dying condition. It is then very conspicuous in contrast to the stems not infested, and ruins the appearance of dahlia plantings. Half a dozen or more larvæ have been cut from a single dahlia flower stem.

The principal point to be considered in connection with the infestation of dahlia plants by larvæ of the borer is that the species may possibly be disseminated through the medium of cut flowers.

Chrysanthemum and Gladiolus.

The stalks of chrysanthemums and gladioli are tunneled by larvæ of the European corn borer in a similar manner and with the same results as has been described for dahlias. Infested chrysanthemum stalks are commonly found in out-of-door gardens during the late summer and fall, and also in greenhouse plots. This characteristic renders chrysanthemums economically important because of the possibility that the pest may be accidentally spread by transporting recently infested plants which have not yet shown external effects of the larval injury.

Infested gladiolus stalks are found in out-of-door gardens during the late summer, and though not as important economically as chrysanthemums, this plant may also be a source of danger through the accidental transportation of infested plants to areas not yet inhabited by the pest.

Timothy and Foxtail.

Small larvæ of the European corn borer have frequently been found feeding upon the seed heads of timothy and foxtail. This damage is not important economically, except that it affords a host for the larvæ of the pest until they have reached a stage in their growth when they are large enough to attack other food plants. Larvæ of the species have never been observed to feed within the stalks of these plants, and the plants are never noticeably injured.

Miscellaneous Plants.

The stalks of lady's-thumb, burdock, horseweed, beggar-ticks, purslane, crabgrass, mare's-tail, panicgrass, goldenrod, thistle and apple of Peru are often entered and tunneled by partly grown larvæ of the European corn borer. These plants are rather numerous in restricted areas through the infested region, and serve as intermediate hosts of the borer, although the plants themselves are of no economic importance.

Celery.

Nearly full-grown larvæ of the borer have been observed to enter and tunnel the outside stems of celery plants. This injury, however, has

been observed in only one field, and in this instance the celery was growing adjacent to a very badly infested field of sweet corn. This corn was inhabited by so many larvæ that the food supply was apparently exhausted, and the larvæ were attracted to the green succulent stems of the celery plants. Several were commonly found in each of the outside stems, but none were found in the stems near the center of the plant.

Similar circumstances to those which resulted in this infestation may be expected to occur from time to time, as celery is frequently grown adjacent to or between the rows of corn plantings.

Celery may be considered an important economic food plant of the European corn borer because of the possibility that plants containing infested stems may be shipped outside the infested area.

Swiss Chard.

The stalk and midrib of the leaves of Swiss chard plants were frequently found infested by the borer under the same circumstances and with the same result as has been recorded in the instance of celery. The injury to Swiss chard, however, was observed in a number of fields in widely separated localities. The green stalks and leaves of this plant are commonly shipped from town to town and must be considered as sources of danger.

Beans.

The pods, immature beans and interior of the vines of bean plants were found infested by larvæ of the European corn borer in several fields. This generally occurred in instances where several crops were planted together, and the bean plants served to accommodate the overflow larvæ from other food plants. The infestation was always found to be very light in character. Under exceptional circumstances the bean plant may become important economically as a host of the borer because of the possibility that larvæ of the species might be transported within the immature pods of string beans.

Potatoes and Tomatoes.

In badly infested areas the larger larvæ of the European corn borer may occasionally be found tunneling the stems of potatoes and tomatoes. Not more than a single larva has ever been observed within a plant, and the injury, so far as observed, is very slight and not at all important commercially.

Beets and Spinach.

Larvæ of the European corn borer are infrequently found tunneling within the leaf stems of beets and spinach during the early fall. This type of injury may be of economic importance because of the possibility that infested plants may be transported for use as greens.

Oats.

The stalks of volunteer oats were found infested by the larger larvæ of the borer in one instance. The injury and its results were similar to that described for other plants with a like habit of growth (pigweed, etc.). Only a very small percentage of oat stalks present was infested.

Oats may become important economically as a food plant of the borer because of the fact that oat straw is often used as packing material.

Turnips.

Large larvæ of the European corn borer were observed feeding upon the outside surface of the tender leaf stems of the turnip. They were not found within the turnip plants, and it is believed that this plant is not at all important as a host of the borer.

DESCRIPTIONS OF THE DIFFERENT STAGES.

THE EGG.

Average length, .97 millimeter; average width, .74 millimeter; circular ovate in shape, slightly convex on its upper surface, flat on its lower surface, or conforming to the shape of the object on which it is deposited. Exochorion sculptured with shallow pentagonal or polygonal pits. Endochorion apparently smooth. Color, when first deposited, opaque white, often strongly iridescent. In from eighteen to twenty-four hours after deposition a crescentiform clear space is formed in the center of the egg on its upper surface. About two days before hatching the egg assumes a yellowish tinge, and soon thereafter the developing larva becomes visible and imparts to the egg a yellow-black appearance.

The eggs are commonly deposited in irregular-shaped masses, each egg overlapped by the adjacent ones in the manner of shingles. Each egg mass is composed of from 5 to 50 eggs.

THE LARVA.

First Instar (see Plate I, Fig. 1). — Average measurements of 11 individuals, newly hatched. Length, 1.6 millimeters; head width, .30 millimeter. Length of head and prothoracic shield, one-fourth total length of larva. Body subcylindrical, opaque white to yellowish green in color. Tubercles large, prominent, pale amber gray. Primary setæ long, amber-colored. Anterior stigmal tubercle on prothorax bisetose, the upper seta the shorter; subventral tubercle also bisetose, the anterior seta the shorter. Tubercles and setæ iv and v are absent on mesothorax and metathorax; coalescent on abdominal segments 1 to 8, inclusive; situated below the spiracle on segments 1 to 7; below and slightly anterior to spiracle on segment 8. Tubercles ia-ib and iia-iiib coalescent on mesothorax and metathorax. Setæ ia and iia are shorter than setæ

ib and iib. Seta iii is of medium length. On the dorsum of abdominal segments 1 to 7, tubercles i and ii form a trapezoidal figure, while on the dorsum of segment 8 they form a nearly rectangular figure. On the dorsum of abdominal segment 9 is a large irregular-shaped, nearly oblong, corneous tubercle bearing a long seta at each of its posterior lateral angles, and a distinct puncture on the median anterior border. The nearly elliptical preanal plate bears two short setæ and one long seta along each of the posterior lateral angles, and one short seta centrally located on each side of the median line. Spiracles protruding, concolorous with tubercles.

Head black or dark brown, declivous and flattened in the newly hatched larva, becoming more rounded as the larva develops. Adfrontal pieces not perceptible in this or succeeding instars until the fifth. Clypeus pale and distinct from frontal piece. Labrum pale, bilobate, with normal arrangement of setæ. Mandibles reddish brown, not protruding. Ocelli six in number, pale and protruding. Antennæ with slight tinge of amber on distal segments.

Prothoracic shield averages .25 millimeter, slightly lighter in color than the head, corneous, almost straight anteriorly, broadly rounded posteriorly. Each half of the shield bears three setæ on the anterior border, two on the lateral posterior border, and one centrally located and near the median line. Bases of setæ surrounded by a black ring. A perceptible indentation, but no division of shield along the middorsal line. Venter of prothoracic segment appears darker owing to presence of dark thoracic shield above.

Thoracic legs, abdominal prolegs, preanal plate and anal prolegs amber. Circle of crotchets on abdominal prolegs broken externally. Thoracic feet and crotchets on abdominal and anal feet pale brown. Thoracic feet corneous.

Second Instar (see Plate I, Fig. 2). — Average measurements of 13 individuals, just molted: Length, 2.625 millimeters; head width, .46 millimeter. Length of head and prothoracic shield, one-sixth total length of larva. Body subcylindrical, amber-white to yellowish green in color. Tubercles large, prominent, pale amber, polished; iv and v present and coalescent on mesothorax and metathorax. Otherwise the arrangements of tubercles and setæ are similar to preceding instar, and remain fairly constant throughout the remaining larval stages. The relative length of the longer body setæ diminishes in each succeeding instar. Spiracles pale amber at center, with black edges. Bases of tubercles and setæ surrounded by a black ring.

Head deflexed. Clypeus pale and distinct from frontal piece. Labrum pale brown. Mandibles reddish brown with black tips. Distal segments of antennæ pale amber, otherwise colorless.

Prothoracic shield averages .414 millimeter wide or nearly equal to that of head. Indentation along middorsal line more pronounced but no division. Venter of prothoracic segment darker.

Thoracic feet and crotchets on abdominal and anal feet dark brown. Preanal plate pale amber.

Third Instar (see Plate I, Fig. 4). — Average measurements of 16 individuals, just molted: Length, 4.75 millimeters; head width, .68 millimeter. Body subcylindrical and darker than preceding instar. Abdominal segments, except 9 and 10, crossed transversely by shallow grooves. Anterior stigmatal and subventral tubercles of prothorax contiguous, nearly concolorous with head and somewhat corneous. Remaining body tubercles as before.

Head deflexed, dark brown in color. Clypeus nearly concolorous with head, and not so distinct from frontal piece. Labrum pale brown.

Prothoracic shield averages .71 millimeter wide. Line of division down middorsal line semi-distinct for one-half distance from anterior border. Venter of prothoracic segment dark.

Thoracic legs, abdominal legs and preanal plate as before.

Fourth Instar (see Plate I, Fig. 6). — Average measurements of 12 individuals, two or three days after molting: Length, 12.5 millimeters; head width, 1.03 millimeters. Body cylindrical, varies in color from opaque white to pale or dark amber. Some individuals show indistinct median and subdorsal longitudinal reddish brown or gray lines on the dorsum. Tubercles of medium size, arranged similar to second instar. Prothoracic tubercles not contiguous, slightly darker than remaining body tubercles. Spiracles nearly concolorous with tubercles.

Head slightly paler than preceding instar. Clypeus not distinctly marked off from front, concolorous with head, trapezoidal; average height, .12 millimeter, average width, .47 millimeter. Labrum dark brown. Mandibles dark brown, not protruding. Distal segments of antennæ dark amber, otherwise nearly colorless.

Prothoracic shield averages .98 millimeter wide, distinctly divided along middorsal line, slightly paler in color than before, and often assuming a yellowish tinge on anterior border. Venter of prothoracic segment slightly darker than venters of remaining segments.

Fifth Instar (see Plate II, Fig. 8). — Average measurements of 13 individuals, three days after molting: Length, 14.46 millimeters; head width, 1.66 millimeters. Body cylindrical, varies in color from dusky opaque white to light pink, with distinct median and subdorsal longitudinal reddish brown, gray or pink lines on the dorsum. Tubercles medium and distinct, pale at center and surrounded by a dusky black ring which in turn is surrounded, on the abdominal segments, by a wider, pale amber-colored band. Tubercles on thorax uniformly dark amber, same arrangement as before. Spiracles nearly concolorous with tubercles.

Head polished dark brown, not quite as high as wide. Clypeus distinctly marked off from front, central area paler than head; average height, .18 millimeter, average width, .66 millimeter. Adfrontal pieces distinct for first time and extend to the vertex. Labrum dark brown

at base, paler at free edge. Mandibles dark brown, protrude slightly. Distal segments of antennæ amber, otherwise colorless.

Prothoracic shield averages 1.72 millimeters wide, more distinctly divided than preceding instar. General color pale brown to pale yellow, polished, with dark brown areas. Anterior border pale yellow. The median posterior margin bears a triangular area, and two large irregular areas are present in a shallow depression near the lateral corners of the shield. The posterior and lateral margins of the shield are dark brown. Bases of setæ surrounded by a distinct black ring. Venter of prothoracic segment only slightly darker than venters of remaining segments.

Prothoracic legs concolorous with head, mesothoracic legs dusky externally, metathoracic legs pale amber. Abdominal and anal legs as before.

Sixth Instar (see Plate II, Fig. 10).—Average measurements of 9 individuals, four days after molting: Length, 19.95 millimeters; head width, 2.19 millimeters. Body cylindrical, abdominal segments, except 9 and 10, crossed transversely by deep grooves. General color darker than preceding instar, varying from dusky pale brown to dark brown or pink. Median line narrow, dark brown and very distinct; subdorsal line vague in outline, broad, pale brown or pink; lateral lines narrow, pale brown. Tubercles medium and darker than general color of body, more pronounced on thorax. Arrangement of prothoracic tubercles and setæ as before. Tubercles *ia-ib*, *iia-iib* and *iv-v* are coalescent on mesothorax and metathorax. Setæ *ia* and *iia* are very much shorter than setæ *ib* and *iib*. Seta *v* is very much shorter than seta *iv*, while setæ *iii* and *vii* are of medium length. Tubercles *iv-v* are coalescent on abdominal segments 1 to 8, inclusive, situated below the spiracle on segments 1 to 7; below and slightly anterior to spiracle on segment 8. On dorsum of abdominal segments 1 to 7, tubercles *i* and *ii* form a trapezoidal figure, as before, while on dorsum of segment 8 these tubercles form nearly a rectangular figure. Large corneous tubercle on dorsum of segment 9, and preanal plate on dorsum of segment 10, with setal arrangement as before. The setæ on lateral anterior borders of prothoracic shield, setæ *ib* and *iib* of mesothorax and metathorax, the setæ on dorsal tubercle of segment 9, and the long setæ on preanal plate are nearly twice as long as any others present.

Head polished brown, with pale brown areas on epicranial lobes. Clypeus as before; average height, .27 millimeter, average width, .84 millimeter. Adfrontal pieces more distinct. Labrum, mandibles and antennæ as before.

Prothoracic shield averages 2.34 millimeters wide. Colored areas on shield similar to preceding instar, with additional small pale brown depressions along each side of median line. The position and form of these colored areas are variable. Venter of prothorax concolorous with venters of remaining segments.

Thoracic, abdominal and anal legs as before.

THE PUPA.

Average length of ♂, 13 to 14 millimeters; of ♀, 16 to 17 millimeters. Average width of ♂, 2 to 2.5 millimeters; of ♀, 3.5 to 4 millimeters.

Color varies from light to dark brown, venter comparatively smooth, dorsum darker in color with fine transverse wrinkles. Form elongate with peculiar "shouldered" appearance of the body, caused by the great width of the thorax as compared with width of the head. Appendages firmly cemented to the body. Wings, maxillæ, antennæ and mesothoracic legs, together with metathoracic legs which lie beneath, are approximately equal in length and extend to the middle of the fourth abdominal segment. Prothoracic legs terminate midway between the head and the tip of the other appendages. Dorsum of thorax very dark, not shiny, with a distinct smooth, slightly elevated ridge extending along the dorso-median line. The fifth, sixth and seventh abdominal segments bear a ridge near the anterior border, which extends completely around the segment. On the dorsum of each of the fourth, fifth and sixth abdominal segments is a transverse line of four bicuspidate projections of the body wall. A pair of proleg scars are visible on the venter of the fifth and sixth abdominal segments. The last segment of the pupa terminates in a dark brown, or black, cremaster, which bears at its extremity eight small spines, arranged transversely, which curve forward at their tips and serve to attach the pupa to its cocoon. Length of these curved spines about .19 millimeter. Spiracles ellipsoidal, prominent and borne on abdominal segments 2 to 7, inclusive. The pupa is always enveloped in a thin cocoon.

The terminal segments of ♂ and ♀ pupæ differ in shape and in arrangement of plates.

THE ADULT.

Alar expanse: male, 24-26 millimeters; female, 29-32 millimeters. Length of body, 13-14 millimeters in both sexes.

Head above covered with light yellowish brown scales, except adjacent to compound eyes, where scales are white; ventral surface, white. Labial palpi porrect; second segment covered with dense projecting, cinnamon-brown to light brown scales attenuated to a point forward; terminal segment concealed; basal segment covered with white scales. An imaginary line, passing through the axis of the body tangent to the lower edge of the compound eye, will divide the labial palpi into two portions according to their coloration, the upper portion being cinnamon-brown, the lower portion white. Maxillary palpi light brownish, erect, slightly dilated and converging at apex. Tip of labial palpi and maxillary palpi the same color in female, labial palpi somewhat darker in male. Proboscis long, with cream-colored scales, usually tightly coiled and almost completely hidden by labial palpi when viewed from the side. Antennæ filiform, two-thirds the length of the front wing, with a longitudinal stripe of cream-colored scales on the posterior side; opposite side brownish.

Terminal half of antenna often curled in preserved specimens. Ocelli present.

Dorsum of thorax cinnamon-brown in male, light yellowish brown in female. Fore legs white exteriorly, fuscous internally. Ventral surface of thorax, mesothorax and metathoracic legs covered with white hairs and scales in both sexes. Inner spurs twice the length of outer ones. Fore wings as wide as hind wings, costal margin gently curved toward apex, anal angle rounded, inner margin straight.

Fore wing of female dull yellow, the costa and inner two-thirds of wing more or less streaked with dull brown; a serrate brown line crosses the wing at about its outer third, followed externally by a narrow yellow band, the outer margin of which is also serrate; external to this is a brown band shot through with yellow toward the outer margin. Hind wing grayish brown, with a rather broad, pale band at the outer third, beginning a little behind the costa and extending nearly to the hinder margin. In some specimens the fore wing colors are dull yellow and cinnamon-brown, and the hind wings very pale brown with faint irregular streaks or shades of darker, instead of as described above; beneath, pale, with faint reproduction of the yellow band on the fore wing, its margins darker but not serrate. Male fore wing somewhat more reddish brown with a yellow discal spot, and a yellow serrate band at the outer third beginning a little behind the costa and often cut into outwardly by inward extensions from the darker color outside, tending to break it into a row of lunate spots; hind wings more gray, with the band of the female hind wing tending to disappear at its ends and become a large, elongate, rather oval area; beneath, dark, with a faint reproduction of the light band of the fore wing and a lighter shade corresponding to the oval area of the hind wing; also light along the inner margin over quite a width.

Fore wing (Plate II, Fig. 12): 1a very weakly developed, bending slightly forward toward 1b at the basal fourth of the latter; 4 and 5 fairly near at base, 5 arising considerably behind the middle of the outer end of the cell; cross vein closing end of cell nearly obsolete from 5 forward; 7 and 8 about as near each other at base as 4 and 5, 8-9 arising from the end of the cell, but almost in contact with 10, which it follows closely for some distance before diverging and forking, 8 extending almost exactly to the apex. Base of 1b enlarged, bearing a tuft of long, forwardly directed hairs beneath. Hind wing (Plate II, Fig. 13) with three anal veins; veins 3, 4 and 5 arising close together; cross vein forming outer end of cell strongly re-entrant: vein 6 leaving the cross vein just before it unites with 7-8. Frenulum in male consists of one long, stout spine; in female (Plate II, Fig. 14), of two long spines and a shorter, more slender one. Ventral surface covered with whitish scales. Dorsum of male cinnamon-brown (excepting first two segments which are amber yellow); of female, amber yellow, the posterior border of each segment with a fringe of white.

LIFE HISTORY.

FIRST GENERATION.

Incubation Period.

The eggs are deposited in masses of from 5 to 50 on the under surface of the upper blades of corn or other food plants. They hatch, on an average, in 7 days, with a maximum of 9 days and a minimum of 5 days (see Table II), the duration of the incubation period depending somewhat upon temperature conditions.

TABLE II. — *Duration of Incubation Period — First Generation.*

Date of Deposition, 1918.	Date of Hatching, 1918.	Incubation Period (Days).	Date of Deposition, 1918.	Date of Hatching, 1918.	Incubation Period (Days).
May 24, . .	June 2, . .	9	May 29, . .	June 5, . .	7
May 25, . .	June 3, . .	9	May 31, . .	June 6, . .	6
May 26, . .	June 3, . .	8	June 1, . .	June 7, . .	6
May 26, . .	June 3, . .	8	June 1, . .	June 6, . .	5
May 26, . .	June 3, . .	8	June 2, . .	June 8, . .	6
May 27, . .	June 3, . .	7	June 2, . .	June 8, . .	6
May 28, . .	June 4, . .	7	June 3, . .	June 10, . .	7
May 28, . .	June 4, . .	7	June 3, . .	June 11, . .	8
May 28, . .	June 4, . .	7	June 4, . .	June 11, . .	7
May 28, . .	June 4, . .	7	June 5, . .	June 12, . .	7
May 28, . .	June 4, . .	7	June 6, . .	June 15, . .	9
May 29, . .	June 6, . .	8	June 7, . .	June 15, . .	9
May 29, . .	June 6, . .	8	June 8, . .	June 16, . .	8
May 29, . .	June 6, . .	8	June 9, . .	June 18, . .	9

Average length of incubation period, ... 7.43 days.

Maximum length of incubation period, ... 9 days.

Minimum length of incubation period, ... 5 days.

Larval Period.

In the course of their development the larvæ feed upon, and within, various parts of their food plant, and pass through from five to eight instars. Out of a total of 20 individuals reared from egg to pupa, in life-history cages 14 individuals required five instars to complete their larval growth, 3 required six instars, 2 required seven instars and 1 individual eight instars. It is probable that, under field conditions, there are normally five or six instars in this generation.

In 20 life-history cages the average duration of the first instar was

7.25 days; second instar, 6 days; third instar, 5 days; fourth instar, 6.5 days; fifth instar, 13 days; sixth instar, 14 days; seventh instar, 8 days; and eighth instar, 13 days. The average duration of the total larval period was 44 days, with a maximum of 57 and a minimum of 35 days (see Table III). The duration of each instar and the total duration of the larval period depend upon temperature conditions.

After reaching full growth the larva forms a cocoon within which it pupates.

TABLE III. — *Duration of Larval Instars — First Generation.*PIGWEED (*Amaranthus*).

DATE OF HATCHING, 1918.	DURATION OF LARVAL INSTARS IN DAYS.								Date of Pupa- tion, 1918.	Days in Larval Period.	Sex.
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.			
June 4, . . .	6	5	5	8	7	14	-	-	July 19	45	♀
June 10, . . .	7	5	6	7	7	10	6	died	-	-	-
June 10, . . .	7	5	6	6	5	7	11	-	July 26	46	♀
June 10, . . .	6	4	7	5	6	7	7	13	Aug. 4	55	♀

DOCK (*Rumex*).

June 15, . . .	4	7	6	6	30	-	-	-	Aug. 7	53	♂
June 15, . . .	4	7	6	9	19	-	-	-	July 30	45	♀
June 15, . . .	4	9	4	6	5	18	-	-	July 31	46	♀
June 15, . . .	4	10	4	8	12	-	-	-	July 23	38 44	♂
June 15, . . .	5	7	5	11	29	-	-	-	Aug. 11	57	-
June 15, . . .	4	8	5	8	4	28	-	-	Aug. 11	56	♀
June 15, . . .	6	6	5	9	19	-	-	-	July 30	45	♂
June 16, . . .	10	5	4	8	9	-	-	-	July 22	36	♀
June 16, . . .	10	5	6	7	15	-	-	-	July 29	43	♀
June 16, . . .	10	4	4	6	13	-	-	-	July 23	37	♀
June 16, . . .	10	5	6	7	8	-	-	-	July 22	36	♀
June 16, . . .	9	5	5	5	13	-	-	-	July 22	36	♂
June 16, . . .	9	5	4	5	12	-	-	-	July 21	35	♂
June 16, . . .	10	6	6	7	13	-	-	-	July 28	42	♀
June 16, . . .	10	6	5	5	17	-	-	-	July 29	43	♂
June 16, . . .	10	5	4	7	17	-	-	-	July 29	43	♀
Average, . . .	7.25	6	5	6.5	13	14	8	13	-	44	-

Average duration of larval period, ... 44 days.
 Maximum duration of larval period, ... 57 days.
 Minimum duration of larval period, ... 35 days.

Pupal Period.

Pupation generally occurs within the tunnels made by the larva, although occasionally it occurs in masses of larval frass, or between closely attached leaves. The duration of the pupal period, in the instance of 49 individuals confined in life-history cages, averaged 8.5 days, with a maximum of 10 and a minimum of 7 days, depending upon temperature conditions (see Table IV).

TABLE IV. — *Duration of Pupal Period — First Generation.*

Number of Observation.	DATE OF —		Number of Days.	Sex.	Number of Observation.	DATE OF —		Number of Days.	Sex.
	Pupa- tion.	Emer- gence.				Pupa- tion.	Emer- gence.		
1-120	July 15	July 24	9	♂	26-147	July 21	July 29	8	♂
2-121	July 15	July 25	10	♂	27-149	July 22	July 29	7	♀
3-122	July 16	July 24	8	♂	28-150	July 22	July 30	8	♀
4-123	July 16	July 25	9	♂	29-151	July 22	July 30	8	♀
5-124	July 16	July 25	9	♂	30-152	July 22	July 30	8	♀
6-125	July 16	July 25	9	♂	31-153	July 22	July 30	8	♀
7-126	July 16	July 26	10	♀	32-154	July 23	July 31	8	♂
8-129	July 17	July 25	8	♀	33-155	July 23	July 31	8	♂
9-130	July 17	July 25	8	♀	34-156	July 23	July 31	8	♀
10-131	July 18	July 26	8	♀	35-157	July 23	July 31	8	♂
11-132	July 18	July 25	7	♀	36-158	July 23	July 31	8	♀
12-133	July 18	July 27	9	♂	37-159	July 23	Aug. 1	9	♂
13-134	July 18	July 25	7	♀	38-160	July 23	July 30	7	♀
14-135	July 19	July 29	10	♂	39-161	July 23	July 30	7	♀
15-136	July 19	July 27	8	♀	40-162	July 24	Aug. 2	9	♂
16-137	July 19	July 28	9	♂	41-163	July 23	Aug. 2	10	♂
17-138	July 18	July 27	9	♀	42-164	July 24	Aug. 2	9	♀
18-139	July 19	July 28	9	♀	43-165	July 24	Aug. 3	10	♀
19-140	July 19	July 28	9	♀	44-166	July 25	Aug. 4	10	♀
20-141	July 19	July 28	9	♀	45-167	July 25	Aug. 4	10	♀
21-142	July 20	July 28	8	♀	46-168	July 26	Aug. 4	9	♂
22-143	July 20	July 27	7	♀	47-169	July 27	Aug. 5	9	♀
23-144	July 20	July 28	8	♀	48-171	July 27	Aug. 6	10	♂
24-145	July 20	July 28	8	♀	49-172	July 27	Aug. 5	9	♀
25-146	July 20	July 29	9	♂					

Average length of pupal stage, ... 8.551 days.
 Maximum length of pupal stage, ... 10 days.
 Minimum length of pupal stage, ... 7 days.

Adult Period.

Soon after emerging from the pupa the female moth begins the oviposition of second generation eggs. With 13 females, confined in individual life-history cages, the average duration of the period, between emergence from the pupa and the first oviposition, was 3.2 days, with a maximum of 9 days and a minimum of 1 day (see Table V).

TABLE V.—*Oviposition by Female Moths in Rearing Cages—First Generation.*

Number of Moths.	SEX.		DATE OF —			NUMBER OF DAYS —			Total Number of Eggs.
	♂	♀	Emergence, 1918.	First Oviposition.	Last Oviposition.	Before Oviposition.	Of Oviposition.	From Emergence to last Oviposition.	
2	1	1	July 25	July 29	Aug. 19	4	22	25	494
3	2	1	July 27	July 29	Aug. 14	2	17	18	590
3	2	1	July 27	July 29	Aug. 11	2	14	15	510
3	2	1	July 27	July 29	Aug. 3	2	6	7	415
2	1	1	July 29	Aug. 1	Aug. 11	3	11	13	594
2	1	1	July 29	July 30	Aug. 16	1	18	18	592
2	1	1	July 29	July 31	Aug. 10	2	11	12	132
2	1	1	July 29	July 30	Aug. 8	1	10	10	626
2	1	1	July 30	Aug. 3	Aug. 26	4	24	27	280
2	1	1	July 30	Aug. 8	Aug. 21	9	14	22	602
2	1	1	July 30	Aug. 3	Aug. 25	4	23	26	786
2	1	1	July 30	Aug. 2	Aug. 13	3	12	14	559
2	1	1	July 30	Aug. 4	Aug. 16	5	13	17	903
29	16	13	—	—	—	—	—	—	—
Average,	.	.	.	.	.	3.2	15	17.23	545
Maximum,	.	.	.	.	.	9.0	24	27.00	903
Minimum,	.	.	.	.	.	1.0	6	7.00	132

The duration of the oviposition period of these 13 females averaged 15 days, with a maximum of 24 and a minimum of 6 days (see Table V).

The average length of life of 23 female moths, confined in cages with male moths, approximating field conditions as nearly as possible, was 18 days, with a maximum of 28 and a minimum of 6 days. The average length of life of 27 male moths in these same cages was 14 days, with a maximum of 35 and a minimum of 3 days (see Table VI).

TABLE VI. — *Length of Life of Male and Female Moths in Captivity — First Generation.*

LENGTH OF LIFE IN DAYS.	Number of Male Moths.	Number of Female Moths.	LENGTH OF LIFE IN DAYS.	Number of Male Moths.	Number of Female Moths.
3.	2	—	17.	2	2
5.	2	—	18.	2	1
6.	2	2	19.	3	1
8.	1	—	23.	1	1
9.	2	—	24.	—	3
10.	3	1	26.	—	1
11.	1	1	27.	—	2
12.	—	1	28.	—	2
13.	1	1	34.	1	—
14.	2	2	35.	1	—
16.	1	2	Totals, ...	27	23

Average length of life: male moths, 13.74 days; female moths, 18.26 days.

Maximum length of life: male moths, 35 days; female moths, 28 days.

Minimum length of life: male moths, 3 days; female moths, 6 days.

It is believed that the duration of adult life, as well as the period before and during oviposition, depends considerably upon the accessibility of the opposite sex, temperature conditions, and the facilities afforded for oviposition. Nevertheless, the data given above were secured under as near natural conditions as could be arranged in cages, and the averages are believed to represent very closely the actual duration of adult periods in the field. These figures are important, showing as they do the comparatively long period during which the adults deposit their eggs.

Life Cycle Summary.

A complete life cycle is here considered to be the total period elapsing from the deposition of eggs of one generation to the time of deposition of eggs of the next generation. Therefore the average duration of the life cycle of the first generation of the European corn borer during 1918 was 63 days, with a maximum of 85 and a minimum of 48 days, as shown by the following table: —

TABLE VII. — *Life Cycle Summary of First Generation.*

	Average.	Maximum.	Minimum.
Incubation period in days, ...	7.43	9.00	5.00
Larval period in days, ...	44.05	57.00	35.00
Pupal period in days, ...	8.51	10.00	7.00
Adult preoviposition period in days, ...	3.20	9.00	1.00
Total, ...	63.19	85.00	48.00

SECOND GENERATION.

Incubation Period.

The eggs are deposited in masses on various parts of the food plant selected for oviposition. They hatch, on an average, in 6 days, with a maximum of 8 and a minimum of 4 days (see Table VIII). Duration of the incubation period depends upon temperature conditions.

TABLE VIII. — *Duration of Incubation Period — Second Generation.*

OBSERVATION NUMBER.	Number of Eggs.	DATE OF —		Duration of Incubation Period in Days.
		Deposition, 1918.	Hatching, 1918.	
200, ...	188	July 29	Aug. 2	4
201, ...	136	July 29	Aug. 2	4
202, ...	107	July 29	Aug. 3	5
203, ...	149	July 29	Aug. 3	5
204, ...	40	July 30	Aug. 5	6
205, ...	87	July 30	Aug. 6	7
206, ...	137	July 30	Aug. 5	6
207, ...	51	July 31	Aug. 6	6
208, ...	46	July 31	Aug. 6	6
209, ...	69	July 31	Aug. 6	6
210, ...	128	July 31	Aug. 6	6
211, ...	87	July 31	Aug. 6	6
212, ...	71	Aug. 1	Aug. 6	5
213, ...	102	Aug. 2	Aug. 7	5
214, ...	103	Aug. 2	Aug. 7	5
215, ...	79	Aug. 2	Aug. 7	5
216, ...	67	Aug. 3	Aug. 8	5
217, ...	89	Aug. 3	Aug. 7	4
218, ...	78	Aug. 4	Aug. 8	4
219, ...	112	Aug. 4	Aug. 8	4
220, ...	101	Aug. 5	Aug. 9	4
221, ...	151	Aug. 5	Aug. 9	4
222, ...	128	Aug. 6	Aug. 12	6
223, ...	77	Aug. 6	Aug. 12	6
224, ...	64	Aug. 7	Aug. 14	7
225, ...	223	Aug. 8	Aug. 14	6
226, ...	75	Aug. 9	Aug. 15	6
227, ...	205	Aug. 9	Aug. 15	6
228, ...	—	Aug. 10	Aug. 16	6

TABLE VIII.—*Duration of Incubation Period — Second Generation — Con.*

OBSERVATION NUMBER.	Number of Eggs.	DATE OF —		Duration of Incubation Period in Days.
		Deposition, 1918.	Hatching, 1918.	
229, ...	100	Aug. 11	Aug. 17	6
230, ...	—	Aug. 12	Aug. 17	5
231, ...	—	Aug. 13	Aug. 19	6
232, ...	—	Aug. 14	Aug. 22	8
233, ...	—	Aug. 15	Aug. 23	8
234, ...	—	Aug. 22	Aug. 27	5
235, ...	142	Aug. 23	Aug. 29	6
236, ...	43	Aug. 23	Aug. 29	6
237, ...	128	Aug. 23	Aug. 29	6
238, ...	76	Aug. 24	Aug. 30	6
239, ...	50	Aug. 24	Aug. 31	7
240, ...	117	Aug. 24	Aug. 30	6
241, ...	163	Aug. 25	Aug. 30	5
242, ...	141	Aug. 25	Sept. 1	7
243, ...	95	Aug. 25	Sept. 1	7
244, ...	46	Aug. 26	Sept. 3	8
245, ...	29	Aug. 26	Sept. 3	8
246, ...	95	Aug. 26	Sept. 3	8
247, ...	68	Aug. 26	Sept. 3	8
248, ...	126	Aug. 26	Sept. 3	8
249, ...	19	Aug. 27	Sept. 4	8
250, ...	27	Aug. 27	Sept. 4	8
251, ...	49	Aug. 27	Sept. 4	8
252, ...	96	Aug. 27	Sept. 4	8
253, ...	70	Aug. 27	Sept. 4	8
254, ...	68	Aug. 29	Sept. 6	8

Average duration of incubation period, ... 6.13 days.
 Maximum duration of incubation period, ... 8 days.
 Minimum duration of incubation period, ... 4 days.

In the course of their development the larvæ of the second generation feed in a manner similar to that described for the first generation. They pass through four or five instars before the advent of severe winter weather, which halts their activities and indefinitely prolongs the duration of the last instar or instars. According to data secured from 25 larvæ, reared in life-history cages from eggs to the time when their activities ceased, the average duration of the first instar was 5.4 days; second instar, 4.2 days; third instar, 5 days; fourth instar, 9 days; and fifth instar, 10 days. The average duration of the total larval period was 26 days, with

a maximum of 32 days and a minimum of 20 days (see Table IX). The duration of each instar and the total duration of the larval period depend upon temperature conditions.

TABLE IX. — Duration of Larval Instars and Activity to Nov. 30, 1918 — Second Generation.

BARNYARD GRASS (*Echinochloa crus-galli*).

DATE OF HATCHING, 1918.	DURATION OF LARVAL IN- STARS IN DAYS.					Date of Pupation, 1918.	Days in Larval Period to Date.	Activities to Nov. 30, 1918.
	First.	Second.	Third.	Fourth.	Fifth.			
August 6, . . .	3	5	8	4	11	-	31	Spun web Sept. 24.
August 6, . . .	3	4	7	5	13	Sept. 14	32	♂ adult Oct. 14.
August 6, . . .	3	5	8	8	-	-	24	Died Nov. 19.
August 6, . . .	3	5	7	5	-	-	22	Died Sept. 6.
August 9, . . .	5	6	5	6	10	-	32	Spun web Sept. 11.
August 9, . . .	4	5	7	5	7	-	28	Died Nov. 15.
August 9, . . .	5	6	5	13	-	-	29	Spun web Nov. 30.
August 9, . . .	5	6	5	9	-	-	25	Died Nov. 3.
August 9, . . .	5	5	6	9	-	-	25	Spun web Oct. 8.
August 9, . . .	6	6	5	9	-	-	26	Spun web Oct. 10.
August 14, . . .	6	4	4	9	8	-	31	Still feeding Nov. 30.
August 14, . . .	7	3	4	7	-	Oct. 1	21	Not emerged Nov. 30.
August 14, . . .	6	4	4	11	-	-	25	Spun web Oct. 21.
August 14, . . .	6	4	4	14	-	-	28	Still feeding Nov. 30.
August 14, . . .	6	3	7	10	-	-	26	Still feeding Nov. 30.
August 14, . . .	6	4	4	11	-	-	25	Spun web Oct. 16.

FOXTAIL GRASS (*Setaria glauca*).

August 14, . . .	6	4	3	7	-	Sept. 5	20	♂ adult Nov. 4.
August 14, . . .	6	5	4	9	-	-	24	Still feeding Nov. 30.
August 14, . . .	7	3	3	8	-	-	21	Died Nov. 30.
August 14, . . .	6	3	6	13	-	-	28	Spun web Oct. 14.
August 14, . . .	6	3	4	10	-	-	23	Died Nov. 30.
August 14, . . .	6	4	4	13	-	-	27	Spun web Nov. 8.
August 14, . . .	7	3	4	11	-	-	25	Died Nov. 30.
August 14, . . .	6	3	4	9	-	-	22	Died Nov. 18.
August 14, . . .	7	3	4	9	-	-	23	Spun web Nov. 2.
Average, . . .	5.4	4.2	5	9	9.8	-	25.7	- -

Average duration of larval period to date, ... 25.7 days.

Maximum duration of larval period to date, ... 32 days.

Minimum duration of larval period to date, ... 20 days.

Three of the larvæ, confined in the life-history cages mentioned, formed pupæ during September and October (see Table IX). This is believed to have been caused by the abnormal conditions which inevitably exist in confinement. No pupæ of this generation were found in the field during the dissection of many hundreds of badly infested plants throughout the months of October, November and early December, 1918.

The second generation larvæ of the borer normally pass the winter within their host plants as full-grown, or nearly full-grown, larvæ in the fifth and sixth instars. With the advent of warm weather in the spring the larvæ begin feeding again, and pupate within a short period of time thereafter.

Pupal Period.

Pupation occurs in a similar manner to that described for the first generation. The duration of the pupal period for 35 individuals confined in life-history cages averaged 17 days, with a maximum of 20 and a minimum of 14 days (see Table X), depending upon weather conditions.

TABLE X. — *Duration of Pupal Period, Second Generation.*

Number of Observation.	DATE OF —		Number of Days.	Sex.	Number of Observation.	DATE OF —		Number of Days.	Sex.
	Pupa-tion.	Emer-gence.				Pupa-tion.	Emer-gence.		
1, . .	May 6	May 24	18	♂	19, . .	May 17	June 3	17	♀
2, . .	May 8	May 26	18	♀	20, . .	May 18	June 3	16	♂
3, . .	May 10	May 24	14	♀	21, . .	May 18	June 4	17	♂
4, . .	May 10	May 27	17	♂	22, . .	May 18	June 4	17	♀
5, . .	May 11	May 29	18	♂	23, . .	May 18	June 4	17	♀
6, . .	May 11	May 28	17	♀	24, . .	May 18	June 4	17	♀
7, . .	May 12	May 28	16	♀	25, . .	May 18	June 4	17	♂
8, . .	May 12	May 29	17	♀	26, . .	May 18	June 4	17	♀
9, . .	May 12	June 1	20	♂	27, . .	May 19	June 4	16	♀
10, . .	May 13	May 31	18	♂	28, . .	May 20	June 6	17	♀
11, . .	May 13	May 31	18	♀	29, . .	May 20	June 6	17	♂
12, . .	May 14	May 30	16	♀	30, . .	May 21	June 7	17	♀
13, . .	May 14	June 2	19	♂	31, . .	May 22	June 7	16	♂
14, . .	May 14	June 2	19	♀	32, . .	May 25	June 12	18	♂
15, . .	May 15	June 2	18	♀	33, . .	May 25	June 9	15	♀
16, . .	May 17	June 2	16	♀	34, . .	May 31	June 17	18	♀
17, . .	May 17	June 3	17	♂	35, . .	June 2	June 19	17	♀
18, . .	May 17	June 3	17	♀					

Average length of pupal stage, ...	17.11 days.
Maximum length of pupal stage, ...	20 days.
Minimum length of pupal stage, ...	14 days.

Adult Period.

The female moth begins the oviposition of first generation eggs within a few days after emerging from the pupa. With 15 females, confined in individual life-history cages, the average duration of the period between emergence from the pupa and the first oviposition was 3.6 days, with a maximum of 7 days and a minimum of 1 day (see Table XI).

TABLE XI. — *Oviposition by Female Moths in Rearing Cages, Second Generation.*

Number of Moths.	SEX.		DATE OF —			NUMBER OF DAYS —			Total Number of Eggs.
	♂	♀	Emergence.	First Oviposition.	Last Oviposition.	Before Oviposition.	Of Oviposition.	From Emergence to last Oviposition.	
8	4	4	May 21	May 24	June 10	3	18	20	1,261
3	2	1	May 24	May 29	June 13	5	16	20	389
3	2	1	May 24	May 28	June 23	4	7	10	190
3	2	1	May 24	May 31	June 6	7	7	13	157
3	2	1	May 24	May 28	June 3	4	7	10	348
3	2	1	May 25	May 28	June 17	3	21	23	727
3	2	1	May 25	May 28	June 16	3	20	22	713
3	2	1	May 26	May 29	June 3	3	6	8	223
2	1	1	May 28	May 29	June 9	1	12	12	107
3	2	1	May 29	June 2	June 16	4	14	18	586
3	2	1	June 1	June 3	June 10	2	7	8	210
3	2	1	June 1	June 8	June 24	7	16	22	137
40	25	15	—	—	—	—	—	—	—
Average, ...						3.66	13.66	16.4	336.53
Maximum, ...						7.00	21.00	23.0	727.00
Minimum, ...						1.00	6.00	8.0	107.00

The duration of the oviposition period of these 15 females averaged 14 days, with a maximum of 21 and a minimum of 6 days (see Table XI).

The average length of life of 29 female moths, which were confined in cages with male moths, approximating field conditions as nearly as possible, was 17 days, with a maximum of 29 and a minimum of 8 days. The average length of life of 40 male moths in these same cages was 13 days, with a maximum of 29 and a minimum of 6 days (see Table XII).

TABLE XII. — *Length of Life of Male and Female Moths in Captivity.*

LENGTH OF LIFE (DAYS).	Number of Male Moths.	Number of Female Moths.	LENGTH OF LIFE (DAYS).	Number of Male Moths.	Number of Female Moths.
6, ...	3	—	19, ...	1	—
7, ...	2	—	20, ...	1	1
8, ...	6	2	21, ...	3	—
9, ...	4	2	22, ...	—	4
10, ...	4	1	23, ...	1	—
11, ...	4	1	24, ...	1	2
12, ...	3	4	25, ...	—	2
13, ...	1	2	26, ...	—	—
14, ...	2	—	27, ...	2	—
15, ...	1	3	28, ...	—	—
16, ...	—	1	29, ...	1	2
17, ...	—	1	Total, ...	40	29
18, ...	—	1			

Average length of life of male moths, 13.1 days; of female moths, 16.86 days.

Maximum length of life of male moths, 29 days; of female moths, 29 days.

Minimum length of life of male moths, 6 days; of female moths, 8 days.

These records were secured in the same manner as has been described in the instance of the first generation adults, and they have the same application and qualification.

Life Cycle Summary.

It is rather difficult to give any accurate figures as to the duration of the life cycle of the second generation of the European corn borer, owing to the varying amount of time spent by the larva in an inactive condition during the late fall, winter and early spring. An attempt will be made, however, to approximate the correct figures by combining the results of the life-history studies as to the duration of the different periods of this generation during the early spring of 1918 and the summer and fall of 1918 up to November 30.

According to these records the average duration of the second generation of the European corn borer was 52.6 days, with a maximum of 67 and a minimum of 39 days, as shown by the following table: —

TABLE XIII. — *Life Cycle Summary of Second Generation.*

	Average.	Maximum.	Minimum.
Incubation period in days, ...	6.13	8.00	4.00
Larval period in days, ¹	25.70	32.00	20.00
Pupal period in days, ...	17.11	20.00	14.00
Adult preoviposition period in days, ...	3.66	7.00	1.00
Total period in days, ...	52.60	67.00	39.00

¹ Excluding winter period of inactivity.

SEASONAL HISTORY AND DEVELOPMENT.

NUMBER OF GENERATIONS.

There are two annual generations of the European corn borer in Massachusetts, a generation here being considered to begin with the egg and terminate with the moth of the same generation.

Eggs of the first generation are deposited during late May or early June, and the resulting larvæ pupate about the middle of July. The moths emerge during late July and early August to deposit eggs of the second generation.

These eggs are deposited, therefore, during late July or early August, and the resulting larvæ feed on, or within, their food plant until the advent of severe winter weather. Feeding is resumed with the coming of warm weather in the spring, and the larvæ pupate about the middle of May. The second generation moths emerge during late May or early June, and deposit eggs for the first generation.

A few moths of the second generation have emerged in life-history cages during September and October (see Table IX), but these individuals died without depositing eggs. Under exceptional circumstances it is possible that moths emerging at this time may deposit eggs for a third generation, but this has not yet been observed.

SEASONAL HISTORY.

The European corn borer passed the winter of 1917-18 as nearly full-grown larvæ of the second generation within their tunnels in various food plants.

The first pupa of the second generation was found in the field May 6, and the majority of the overwintering larvæ pupated between May 15 and 20.

The first moth of the second generation was observed in the field on May 16. Moths began to emerge from indoor cages May 18, and maximum emergence occurred during the period from June 1 to 4. The last emergence of second generation moths was recorded on July 9, from laboratory cages (see Table XV).

Oviposition of second generation moths occurred within a few days after emergence, and extended over a period of about two weeks. Eggs of the first generation were first secured in life-history cages on May 24 (see Table XI).

Larvæ of the first generation were first secured in life-history cages on June 2 (see Table II), and were observed for the first time in the field on June 13.

The first pupa of the first generation was found in the field on July 11, and in life-history cages on July 15. Maximum pupation took place between July 19 and 23 (see Table IV).

Emergence of first generation moths began about July 23 and reached its maximum between July 27 and August 4. The last emergence of first generation moths was recorded from indoor cages on August 29 (see Table XIV), and from corn in the field on September 6.

On July 29 the first eggs of the second generation were secured in life-history cages (see Table V). Eggs of this generation were first observed in the field on August 13.

Larvæ of the second generation were first secured in life-history cages on August 2 (see Table VIII), and were observed for the first time in the field on August 13. On this date some of the larvæ in the field were in the second and third instars. On September 2 many of the larvæ in the field were in the fifth and sixth instars. When the last field observations were made, on November 30, most of the larvæ were in the fifth and sixth instars, and in this stage of their development they probably will pass the winter of 1918-19.

SEASONAL ABUNDANCE.

The larvæ of the borer reach their greatest abundance and do the most damage to corn and other host plants during the late summer and fall. The damage to early corn by larvæ of the first generation during June and July is much less than the damage to late corn by those of the second generation during August and September. The same is true for the other host plants infested by the insect.

There is quite a heavy mortality of overwintering larvæ, due to natural causes, and this when added to the high percentage of overwintering larvæ destroyed by control measures and cultural practices, greatly reduces the numbers of the pest that remain to perpetuate the species in the spring. Consequently the first generation of larvæ is much smaller in numbers each year than the second generation of the preceding year.

HABITS OF LARVÆ.

HATCHING.

About a day before hatching takes place, the black eye spots and reddish mandible tips of the developing larva may be seen through the semi-transparent chorion of the egg. A few hours before hatching, the head

and thoracic shield become black and are observed to occupy a central position in the egg. The body segmentation and the black spines on the body of the larva are also plainly discernible. At this time the developing larva is curled up inside the egg with its mandibles resting upon the next to the last abdominal segment. These mandibles soon begin to move laterally, and the larva straightens itself out in such a manner that the mandibles are brought into contact with the eggshell. A slit in this is soon made, and the larva crawls forth. After hatching, the larva feeds, to some extent, upon the empty eggshell, but has not been observed to entirely devour it.

HABITS WHEN ATTACKING CORN.

First Generation.

The newly hatched larva crawls about over the surface of the corn blade on which it hatched, stopping here and there to eat a small area of the epidermis on either the upper or lower surface of the blade (see Plate I, Fig. 1). These small areas are usually bordered by veins on each side and are longer than wide.

During its travels the larva gradually approaches the growing crown of the plant, and, upon reaching it, descends between the rolled leaf blades, or cone, composing the crown, and feeds internally upon the young and succulent epidermis of the unfolding leaf blades. If the tassel is present within the cone the first instar larvæ may feed upon the epidermal cells composing the flower buds, but only rarely do larvæ of this instar enter the buds.

When ready to molt, the first instar larva spins a thin, silken molting cocoon in some protected location near its last feeding place, within which it molts to the second instar.

Upon emerging from its molting cocoon this larva immediately attacks the staminate flower buds if the tassel is present within the crown. If the tassel is not present it feeds on the tightly rolled leaf blades composing the crown in a similar manner to that described for the first instar, except that larvæ of the second instar are able to eat entirely through the blade, and do not confine their feeding to the epidermis. When the tassel is present within the crown the second instar larva bores a hole in the side of one of the staminate flower buds and feeds upon the internal succulent contents. Entrance to the bud may be effected from the top, at the base or from the side, several buds are destroyed in turn by each larva. During the process of feeding within the buds considerable frass is extruded, and this becomes webbed together with the silk spun by the larva in traveling from bud to bud, and forms a certain amount of protection for the larva. This webbing together of frass for possible protection is characteristic of the second generation larva, as, although larvæ of the first and later instars are capable of spinning a web, they do not use it for purposes of protection while feeding.

When ready to molt, the second instar larva spins a molting cocoon,

within which it molts to the third instar. This molting cocoon may be located within a single, hollowed-out flower bud, or may be situated beneath the webbed-up frass from several flower buds.

The third instar larva feeds at first within the staminate buds of the tassel in a similar manner to that described for the second instar larva, but, when a little older, it may enter the terminal spike of the tassel, 1 or 2 inches above the last branch, and tunnel within this spike, and a small mass of frass collects at the point of entrance and renders the injury conspicuous. Instead of entering the tassel, many third instar larvæ tunnel within the midrib of the leaf blade. These tunnels are never more than 1 or 2 inches in length, and closely resemble the injury to the tassel spike. Whether the third instar larva tunnels in the terminal spike, in the midrib of the leaf, or continues feeding in the ends, appears to be arbitrary with the individual.

The third instar larva may molt to the fourth instar, either within its tunnel or in some protected place outside. If molting occurs within its tunnel, a molting cocoon is not formed, but a silken partition is spun across the entrance hole. If molting occurs in some protected place outside the tunnel, a typical molting cocoon is formed, and the larva molts to the fourth instar in a similar manner to that described for the preceding ones.

After molting to the fourth instar the larva usually enters the main stalk of the tassel 1 or 2 inches from its base. Sometimes it enters the terminal internode at the point where the first leaf blade joins its sheath. Later the terminal internode of the corn plant grows so that this entrance point, instead of being present at the junction of the leaf blade and the leaf sheath, is found 5 or 6 inches above that point. After cutting an entrance hole in the side of the stalk the larva tunnels out a small, spherical cell, which occupies nearly all the interior of the stalk at this point. From this it usually tunnels upward for 2 or 3 inches above the entrance hole, and then returns and tunnels downward. During this feeding a large amount of frass is pushed out of the entrance hole and is held there by means of small silken strands spun by the larva. This large mass of yellow-white frass is very conspicuous, and serves to identify infested tassels, even before they break over. Eventually the tassel becomes broken over at the point where the fourth instar larva entered the terminal internode.

The fourth instar larva molts to the fifth instar within its tunnel, and only spins a silken partition across its entrance, thus using its tunnel for a molting cocoon.

The fifth instar larva may complete its larval development within the terminal internode. The number of larval instars varies with different individuals, five being sufficient to complete the larval growth in some individuals, while six, or even seven or eight, instars are passed through in other cases. In the majority of instances, especially when an abundant supply of food is available, the fifth instar is the last and longest of the

larval instars. During this, or the succeeding instars, the larvæ sometimes wander about and do their greatest amount of damage to the plant. Some individuals leave the terminal internode and tunnel through the lower parts of the stalk; some tunnel from the terminal internode down through the intervening nodes into the lower part of the stalk; while others enter the stalk at various places along its length and tunnel upward or downward according to their individual preference. The junction of the leaf sheath and node is a favorite point of entrance, although this is by no means universal. Frequently the larva enters a stalk and tunnels out a cavity, only to abandon it and enter the plant at a different point. The stalk may be tunneled by the larvæ to its base, or even into the taproot, so that corn stubble is often infested and must be considered a source of danger in clean-up operations.

During their wanderings the larger larvæ very often descend the plant until they reach the side branch, or pedicel, on which the ear is borne. Here they may enter the main stalk or may enter the pedicel and tunnel into the ear. Some enter the ear directly by boring through the husk, later feeding on the immature kernels or tunneling through the cob. In other instances the ear is entered at the tip end, and the larvæ tunnel through the kernels and the cob. Apparently the ear is very much favored as a food by the larvæ.

In instances when the fifth instar larvæ molt into the sixth, seventh or eighth instars (see Table III), the molting process takes place in the same manner and location as has been described for the fourth to fifth instar molt.

The habits of the larvæ vary greatly with different individuals and under different environments. For this reason the preceding remarks are intended to give only an idea of their usual activities in this stage, and their habits when attacking corn. In general, it may be stated that they may attack all parts of the corn plant except the fibrous roots, and that this damage may occur in an indefinite number of ways by larvæ of the different instars.

Second Generation.

When attacking corn the habits of the second generation larvæ are essentially the same as have been described for those of the first generation.

The only exception is that a large proportion of the larvæ hatch from eggs which have been deposited directly upon the silk or husk of the immature ears. They feed first upon the tender leaves of the husk, and upon the silk, and then tunnel through all parts of the ear. This type of injury is of great economic importance, especially in sweet corn or that grown for seed. The amount of damage to corn by larvæ of the second generation is, therefore, infinitely greater than that caused by those of the first generation, due to the greater numbers of the second generation and their habit of attacking the ears directly.

The nearly full-grown larvæ winter over within their tunnels in the

stalk, in the ear or in the taproot. They do not generally spin any protective cocoon, but remain quiescent during the cold weather. Feeding is resumed during the warm portions of pleasant days in early spring, but the larvæ return temporarily to their quiescent state during cold nights or inclement and cold spring weather. The hardened condition of stalks and ears during the spring does not appear to present any difficulties to them, as they tunnel through all parts of the plant with the same apparent ease as when the plants were comparatively soft and green the preceding season. Cobs of seed corn, which had been stored on the cob all winter and were very hard and dry, contained living larvæ of the borer in April, 1918. That they had been feeding during the warm periods of the early spring was evidenced by the mass of frass extruding from their tunnels. This occurrence will serve to illustrate the danger of disseminating the pest by the transportation of corn on the cob.

HABITS WHEN ATTACKING DOCK.

The first instar larva of the European corn borer feeds, to some extent, on the tender seed heads of the dock plant, and also upon the epidermis of the leaves, but soon works its way down between the main stalk and a leaf sheath. Here the first molt occurs, and the second instar larva feeds on the leaf sheath, the basal part of the leaf petiole, and on the small secondary stalks which arise at the junction of the leaf and the stalk. When the leaf petiole is tender enough the second instar larva usually tunnels into it and molts into the third instar, either in this location or at the base of the leaf petiole when it has been unable to effect an entrance. The third instar larva usually tunnels in the leaf petiole and molts to the fourth instar within its tunnel. Occasionally the third instar larva does not feed within the leaf petiole, but enters the main stalk at the junction of the petiole and stalk. Normally, the larva does not enter this main stalk until the fourth instar is reached. After entering the stalk it usually tunnels downward through the nodes and internodes, practically consuming the interior of the stalk. The remaining instars are passed, and the larva becomes full grown and pupates, within this tunnel. A large quantity of frass is extruded by the larva through the entrance hole, and becomes webbed into the axial flowers situated between the main stalk and the petiole. This accumulation of frass makes infested dock plants very conspicuous, even before the upper portion of the plant breaks over at the entrance hole of the larva.

By the 1st of August nearly all of the dock plants are dead, so the activities of the European corn borer in this plant are confined to the first generation.

HABITS WHEN ATTACKING LADY'S-THUMB.

In this common host plant of the European corn borer the first instar larva tunnels directly into the main stalk at a point about 1 or 2 inches below the terminal leaves. Soon after the plant is attacked it may easily

be distinguished from those not infested, as the terminal stalk withers and droops above the point where the small, first instar larva entered. After entering the stalk it tunnels downward, molting within the tunnel as it develops in size. This tunnel is not continuous, owing to the fact that the larva emerges from the stalk at will, and enters again at a point nearer the base. It usually tunnels exclusively in the internodes of this plant, very rarely passing through a node. In this particular the habits of the larva, when attacking lady's-thumb, are distinctive because the node is commonly tunneled in other plants.

HABITS WHEN ATTACKING BARNYARD GRASS.

The habits of the European corn borer larvæ, when attacking barnyard grass, are very similar to those that have been detailed in the injury to dock, except that the larger ones, instead of continuing to feed on their original host, often leave the stalks of barnyard grass, where they have partially completed their development, and enter others.

Barnyard grass commonly serves as a host for the second generation larvæ until the middle of October. At this time it becomes dry and hard, and many of the larvæ desert it for more attractive food plants growing in the vicinity, though a large percentage of the original number present continue feeding in the lower parts of the plant, and may be found inside the base of the stalk, below the level of the ground, as late as November 30. It is believed that the nearly full-grown larvæ pass the winter in this location, although complete data on this point will be lacking until observations are made in the spring of 1919.

Superficial observers have frequently stated that barnyard grass is entirely deserted by larvæ of the European corn borer during the late fall season, but close examination will reveal many at the bases of the stalk. In this position they are very difficult to destroy by ordinary clean-up methods.

MOLTING.

When feeding on, or near, the surface of its food plant, especially during the early instars, the larva spins a molting cocoon within which it molts. This is formed of thin, silken strands, and is located in any protected place. When tunneling inside its food plant the larva does not form a molting cocoon, but merely closes the entrance to the tunnel with a thin, silken partition. It then molts inside this tunnel near its last feeding place.

The process of molting varies in detail with the different instars, but in general is as follows. After all preparations to secure protection have been made, the larva enters a semi-quiescent state during which the head capsule becomes pushed forward until a distinct non-contractile, white band appears between the head and the shield. After remaining in this condition approximately twelve to twenty-four hours the old larval skin splits longitudinally just back of the head capsule, and, as a result of

squirring movements from within, slips down and off the molting larva. When nearly free of the old larval skin the larva easily brushes off the old larval head mask, or remains of the head capsule.

The newly molted larva is colorless, with an opaque, white head capsule and thoracic shield. In the course of two or three hours its body assumes the characteristic markings for the instar, while the head and thoracic shield darken and become fully pigmented.

After completing its emergence and coloring the larva remains quiet until the body chitin becomes hard, and then resumes its activities.

LENGTH OF LARVAL LIFE WITHOUT FOOD.

Newly hatched larvæ of the European corn borer lived a maximum of two days in life-history cages without food or water.

Nearly full-grown larvæ, isolated in glass vial cages, without food or water, lived a maximum of thirty days during the active season.

This latter characteristic is important with relation to the possible transportation of infested material to localities not infested by the insect. The long period of life without food would allow larvæ to survive under very adverse conditions, and to start new colonies of the insect when opportunity afforded.

UNUSUAL HABITS.

Large larvæ of the European corn borer will eat their way through an ordinary cork stopper and escape from confinement. They are unable, however, to make any impression upon a cotton plug, and are easily confined in glass vials when these are plugged with cotton.

Larvæ also eat through paper and pasteboard. On one occasion a full-grown larva, which had escaped from an indoor cage, tunneled through heavy pasteboard surrounding a bottle, and pupated between the bottle and its covering.

Full-grown larvæ have been observed crawling along the ground at some distance from any possible food plant. In cases of necessity these larvæ could probably travel a considerable distance.

Large larvæ have been found underneath clods of earth and underneath rubbish in badly infested fields, due possibly to some agency which forced them to leave their natural protection within the food plant.

Infested cornstalks were buried in the soil to a depth of 6 inches during the spring of 1917. Within a few days the larvæ deserted the buried cornstalks and made their way to the surface.

Although the larger larvæ normally feed within the plant, occasionally individuals are found feeding on its exterior. This is especially true of the full-grown larvæ just before pupation. At this time they are frequently found feeding on the silk and on the outer husk of the ear.

PUPATION.

LOCATION OF PUPA.

Normally the pupa of the European corn borer is found inside the tunnel made by the larva, and not far from its last feeding place. A small per cent of the full-grown larvæ, however, leave the interior of the plant when attacking corn and pupate in some protected place near by, such as the silk of the ear; between the husks of the ear; in a fold of the leaf blades; between two overlapping leaf blades; in the frass clinging to the tassel; in the frass at junction of leaf blade and leaf sheath; between the leaf sheath and stalk; and on the surface of the ear in the hollow made by the feeding larvæ.

Though in corn most of the larvæ pupate within their tunnels in the stalk or in the pedicel of the ear, many pupæ are found inside the cob and in the upper part of the taproot.

COCOON FORMATION.

Most of the following remarks concerning cocoon formation apply only when the larva forms its cocoon and pupates within the larval tunnel.

When the larva reaches full growth and is ready for pupation it cuts a circular exit hole to the surface of the plant. It then spins a silken partition across this exit hole from within, and this partition serves to block the outside entrance to its pupal chamber. It then retreats about 2 inches into its tunnel, and forms the base of its pupal chamber by packing the tunnel with a layer of frass about an inch thick. A silken partition is then spun on top of this protecting layer, and frequently another transverse partition of silk is spun about a quarter of an inch above this lower one. After thus closing both ends of the tunnel the larva proceeds to coat the walls of its pupal chamber with a very thin layer of silk, and then spins a single internal partition, also of silk, across the upper part of the pupal chamber and parallel to the exit hole. The larva then constructs two slanting partitions in the lower part of its pupal chamber, which intersect each other and form a partition resembling the letter "Y."

After completing the bottom partitions of the pupal chamber the larva turns around and begins forming the upper ones. These are quite similar to the lower, but are usually more complicated and more substantial. They consist of a series of four or five intersecting partitions of silk which meet in the center to form a letter "Y", and make an angular roof over the head of the larva. The cocoon is then complete. About three or four days are usually required by the larva for its formation.

After completing the upper partitions of its pupal chamber the larva attaches its anal legs firmly to the angle of the "Y" in the bottom partition, and then passes into a semi-quiescent state.

CHANGES UNDERGONE BY THE LARVA PREVIOUS TO PUPATION.

In the semi-quiescent state the larva is very sluggish, but is still capable of locomotion. Soon after entering this stage the head starts to bend downward, and the mouth parts become ventral instead of anterior. The second thoracic segment becomes swollen, and the third thoracic and first abdominal segments become compressed as a result of pressure exerted at the anterior and posterior ends of the larva. The second and third abdominal segments remain about normal, while the fourth to seventh become enlarged and swollen, and show distinctly the outlines of the pupal abdomen. At the termination of the semi-quiescent stage, which lasts for about twenty-four hours, the larval head is fully inflexed and the use of both thoracic and abdominal legs is lost. The larva then enters the true quiescent state.

In this stage the larva is not capable of locomotion, but has the characteristic movements of a pupa. Soon after entering this stage the contents of the terminal segments of the larva shrink away from the larval body wall to form the terminal segments of the pupa. At this time the anal legs consist of only the external chitinous covering, with their crotchets firmly attached to the bottom silken partition. When disturbed the larva twitches and turns with a movement resembling that of the pupa, while the empty anal legs remain attached to the silk and are often twisted around each other during the twisting movements of the larva. At this time the abdominal legs are flush with the venter, and the thoracic legs are folded close to the body. The quiescent stage requires from twelve to twenty-four hours for its completion, and then the larva begins the process of pupation.

PROCESS OF PUPATION.

After a few straining movements forward, and as a result of pressure exerted from within, the larval skin suddenly splits along the dorsal line of the head and thoracic segments, and also down each side of the frontal head plate. After a few wriggling movements the larval skin slips down to the terminal segment, which then is liberated. As soon as it is freed from the larval skin the newly formed pupa turns around two or three times, thus firmly attaching its cremaster to the angle of the lower silken partition in the pupal chamber, at the point formerly occupied by the anal feet of the larva. A timed individual required two and one-half minutes to shed its larval skin, except the terminal segment, and the total time required to completely shed this skin and attach the cremaster was eight minutes.

CHANGES UNDERGONE BY THE PUPA.

The newly formed pupa is white in color, with a longitudinal pink line down the dorsum. Transverse pink lines extend across the center of the dorsum of each abdominal segment, but fade away laterally. The wing pads are yellow with a tinge of pink. The venter of the abdomen is

creamy white throughout. The cremaster and its spines, and also the chitinous braces arising from the last segment, are dark red.

About one hour after pupation the transverse pink lines gradually widen and become darker in color, until the dorsum, except at the union of segments, is yellowish red. At this time the venter is almost pure white, but soon begins to turn pinkish yellow in the posterior half of each abdominal segment. This color then extends to include the entire venter of each abdominal segment. The terminal abdominal segment assumes its permanent color at this time. As permanent coloration proceeds, the dorsum of the thorax and abdomen, together with the wing pads, turn a darker red, and soon assume their permanent color. In approximately five or six hours after its formation the pupa is fully colored, and retains this coloration until about three or four days before the emergence of the moth. At this time it becomes very much darker and shows the adult markings.

HABITS OF ADULTS.

EMERGENCE OF THE MOTHS.

After loosening its appendages the emerging moth pushes off the head cap of the pupal skin by exerting pressure from within, and frees itself until the head and eyes are visible. Here the moth rests for a few seconds before struggling completely out of the pupal skin. About two or three minutes are required for the moth to entirely free itself. At this time the wings of the moth are only partly developed, and are practically the size of the pupal wing pads. In this condition the moth escapes from the cocoon and crawls to the surface of the plant, providing pupation occurred within interior tunnels. After reaching the surface the moth obtains a foothold and assumes a perpendicular position. It is never found in a horizontal position at this time. The wings then lengthen and widen gradually, meanwhile being brought vertically over the body and held in this position until fully expanded. After reaching their full development and expansion the wings are lowered to their normal position of rest, and within a few hours the moth is ready to assume its adult activities.

Maximum adult emergence generally occurs very early in the morning, and the moths seldom emerge at any other time, unless the early morning hours are rather cold. In this event the moths are delayed in emerging until the early forenoon. A few, however, have been observed to emerge late in the afternoon.

COPULATION.

Copulation occurs within twenty-four hours after the sexes emerge from the pupa, and at frequent intervals throughout the life of the adult, — thirteen to eighteen days' average (see Tables VI and XII). Late afternoon or evening, when the adults are most active, is the usual time for copulation. The act is accomplished in a similar manner to that of other lepidopterous adults.

Polygamy experiments were tried during the summer of 1918, but no

definite data were secured as to the number of females fertilized by each male. Bearing in mind the long period of adult life, however, it is probable that each male will fertilize several females.

PROPORTION OF SEXES.

First Generation.

A total of 317 first generation pupæ were collected from the field in July, 1918, and confined in individual cages. From these a total of 317 first generation adults emerged, of which 136, or 42.9 per cent, were males, and 181, or 57.1 per cent, were females (see Table XIV).

TABLE XIV. — *Proportion of Sexes and Time of Emergence of Moths, First Generation.*

DATE OF EMER- GENCE, 1918.	Number of Males.	Number of Females.	Total Emer- gence.	DATE OF EMER- GENCE, 1918.	Number of Males.	Number of Females.	Total Emer- gence.
July 23, . . .	1	-	1	August 12, . .	2	-	2
July 24, . . .	4	-	4	August 13, . .	3	3	6
July 25, . . .	5	6	11	August 14, . .	6	3	9
July 26, . . .	2	3	5	August 15, . .	5	1	6
July 27, . . .	9	8	17	August 16, . .	-	1	1
July 28, . . .	10	14	24	August 17, . .	-	2	2
July 29, . . .	14	22	36	August 18, . .	-	-	-
July 30, . . .	9	27	36	August 19, . .	-	-	-
July 31, . . .	14	15	29	August 20, . .	1	1	2
August 1, . . .	2	-	2	August 21, . .	3	1	4
August 2, . . .	8	17	25	August 22, . .	4	4	8
August 3, . . .	4	8	12	August 23, . .	4	1	5
August 4, . . .	5	7	12	August 24, . .	1	7	8
August 5, . . .	2	7	9	August 25, . .	2	3	5
August 6, . . .	4	4	8	August 26, . .	-	-	-
August 7, . . .	1	7	8	August 27, . .	1	-	1
August 8, . . .	4	3	7	August 28, . .	-	-	-
August 9, . . .	1	2	3	August 29, . .	-	1	1
August 10, . .	3	1	4	Total, . . .	136	181	317
August 11, . .	2	2	4				

Total emergence, 317 adults.

Total males, 136, or 42.9 per cent.

Total females, 181, or 57.1 per cent.

A total of 49 first generation pupæ were reared from full-grown, first generation larvæ collected in the field during July, 1918, in order to secure data as to duration of the pupal period. From this material a total of 49 first generation adults emerged, of which 19, or 38.8 per cent, were males, and 30, or 61.2 per cent, were females (see Table IV).

On the night of August 6-7, 1918, 17 first generation moths were captured at a trap light. Of these, 7, or 41.2 per cent, were males, and 10, or 58.8 per cent, were females.

Thus out of a total of 383 first generation adults, 162, or 42.3 per cent, were males, and 221, or 57.7 per cent, were females.

Second Generation.

In April, 1918, two barrels of badly infested cornstalks were collected and placed in the laboratory in order to secure data as to adult emergence, proportion of sexes, etc. From these two cages 307 second generation adults emerged, of which 160, or 52.1 per cent, were males, and 147, or 47.9 per cent, were females (see Table XV).

TABLE XV.—*Proportion of Sexes and Time of Emergence of Moths, Second Generation.*

DATE OF EMER- GENCE, 1918.	Number of Males.	Number of Females.	Total Emer- gence.	DATE OF EMER- GENCE, 1918.	Number of Males.	Number of Females.	Total Emer- gence.
May 18, . .	1	—	1	June 11, . .	—	—	—
May 19, . .	6	4	10	June 12, . .	1	5	6
May 20, . .	5	2	7	June 13, . .	2	2	4
May 21, . .	2	5	7	June 14, . .	1	2	3
May 22, . .	3	6	9	June 15, . .	2	3	5
May 23, . .	1	1	2	June 16, . .	1	3	4
May 24, . .	14	7	21	June 17, . .	3	—	3
May 25, . .	7	2	9	June 18, . .	1	—	1
May 26, . .	9	3	12	June 19, . .	1	2	3
May 27, . .	5	1	6	June 22, . .	1	1	2
May 28, . .	2	5	7	June 23, . .	1	—	1
May 29, . .	8	7	15	June 24, . .	1	2	3
May 30, . .	2	—	2	June 25, . .	—	2	2
May 31, . .	2	6	8	June 26, . .	—	3	3
June 1, . .	12	8	20	June 27, . .	—	2	2
June 2, . .	12	19	31	June 28, . .	1	—	1
June 3, . .	17	16	33	June 29, . .	2	—	2
June 4, . .	9	7	16	June 30, . .	1	1	2
June 5, . .	3	1	4	July 1, . .	1	—	1
June 6, . .	6	3	9	July 2, . .	—	3	3
June 7, . .	2	4	6	July 4, . .	1	—	1
June 8, . .	4	2	6	July 5, . .	—	1	1
June 9, . .	3	1	4	July 9, . .	—	1	1
June 10, . .	4	4	8	Total, . .	160	147	307

Total emergence, 307 adults.

Total males, 160, or 52.1 per cent.

Total females, 147, or 47.9 per cent.

A total of 35 second generation pupæ were reared from full-grown second generation larvæ collected in the field during May, 1918, in order to secure data as to duration of the pupal period. From this material 35 second generation adults emerged, of which 13, or 37.3 per cent, were males, and 22, or 62.7 per cent, were females (see Table X).

Thus out of 342 second generation adults, 173, or 50.5 per cent, were males, and 169, or 49.5 per cent, were females.

It will be noted that, in the instance of the 725 adults of both generations represented by these figures, the sexes were present in nearly equal proportions, there being 335 males and 390 females.

FLIGHT.

Character of Flight.

Both sexes of the European corn borer adults are capable of flight. They habitually fly very close to the ground, a tendency that is caused, perhaps, by the fact that the plants upon which the females deposit their eggs do not generally reach a height of more than 6 or 8 feet. When disturbed in their hiding places during the day the adults fly close to the ground, in a curious zigzag manner, for a distance of 10 or 20 feet, and then seek cover again under some object.

It is rather difficult to observe the flight of the adults during the time of their maximum activity in the early evening. Such observations as were made, however, indicated that adults normally fly very low, even when seeking food plants upon which to deposit their eggs. The males apparently are more active than the females, and fly for greater distances and at higher altitudes. The character of their flight at this time is similar to that which has been described in the instance of moths disturbed from their hiding places during the day.

Distances of Flight.

Under most conditions the moths cover a very short distance in each flight, the maximum observed in any single flight being about 50 yards. The females make a series of short flights in search of food plants on which to deposit their eggs, so that the total distance covered by a female in a series of flights may be considerable. The males make a similar series of flights in their search for the females.

Effect of Wind on Flight of Moths.

It is not believed that the moths are carried any considerable distances by the wind, although the general direction in which the insect has spread, since its introduction into Massachusetts, has been with the prevailing winds.

Meteorological records show that these winds during May, June, July and August are from the south and the southwest. The fact that the insect has spread more rapidly toward the north and the north-

east than in any other direction would tend to indicate that the flight of the moths is influenced by the wind to some extent.

The habit of the moth of flying close to the ground would seem to reduce the possibility of wind spread to a minimum, but future observations may show other influencing factors.

Time of Maximum Activity.

During the day the moths remain inactive. They may commonly be found hiding on the underside of the foliage of their food plant, or in strips of grassland and low weeds growing along the field borders and ditches of cultivated areas. They also remain inactive during cool periods, and also during high winds. They become active in the late afternoon, and reach their greatest period of activity about dusk.

Attraction of Moths to Trap Lights.

On the night of August 6-7, 1918, a trap light was placed midway, and 50 feet distant, from two areas of sweet corn which contained hundreds of first generation adults. These had recently emerged from early corn and were at the period of their greatest activity. The trap light was started at 8 P.M. At this time the moths were actively flying around among the corn plants. The first moth was caught at 8.45 P.M. Observations were continued until 11.30 P.M., and the trap light was left burning until 8 A.M. the next morning. The total catch from this trap light experiment was 17 moths, of which 7 were males and 10 were females. Subsequent dissection showed that all of the females were gravid.

The trap light used in the experiment was yellow in color. Examination of blue arc lights along the streets in the vicinity of badly invested areas failed to show that the moths were attracted to the blue lights to any greater extent than has been detailed for the yellow light.

OVIPOSITION.

The females of the European corn borer begin ovipositing about three days after emerging from the pupa (see Tables V and XI). Oviposition generally occurs during the late afternoon or early evening.

DETAILS OF OVIPOSITION.

The female assumes a position on the under surface of a leaf blade, and bends the end of the abdomen down, meanwhile extruding the ovipositor until its tip comes in contact with the leaf blade. The tip of the ovipositor is fleshy and circular. Around its periphery extends a circle of amber-colored hairs. After selecting the spot on which the egg is to be deposited the female stands still and vibrates the ovipositor until the spherical-shaped egg appears at its tip. The egg is then quickly pushed against the leaf and tamped down into place by the ovipositor, which at the same time flattens it. This act changes the egg from its original spherical

shape into a more flattened one. From 5 to 50 eggs are thus deposited in a flat egg-mass, each egg overlapping the adjoining one in the manner of shingles. The female rarely changes her position during the oviposition of an egg-mass, as the flexibility of the abdomen allows quite a radius of action.

DISTRIBUTION OF EGG MASSES.

During its period of fertility the female deposits a varying number of egg-masses, each mass being composed of from 5 to about 50 eggs. These are generally placed on the under sides of the leaves of several different plants, but in some instances all of the eggs may be deposited on the same plant. When selecting plants for egg deposition the female apparently prefers certain plants to the exclusion of others belonging to the same species.

In life-history cages the daily rate of oviposition varied with different females and according to the temperature conditions. In some instances a single female deposited several egg-masses in twenty-four hours, while in other instances a period of several days elapsed between the deposition of successive egg-masses.

TOTAL NUMBER OF EGGS DEPOSITED BY EACH FEMALE.

First Generation.

In life-history cages 13 female moths of the first generation deposited an average of 545 eggs each. The maximum number of eggs deposited by a single female was 903, and the minimum, 132 (see Table V).

Second Generation.

In life-history cages 15 female moths of the second generation deposited an average of 337 eggs each. The maximum number of eggs deposited by a single female was 727, and the minimum, 107 (see Table XI).

DURATION OF FERTILITY.

The duration of fertility is here considered to be the period between the first and last deposition of eggs.

First Generation.

The duration of fertility of 13 female moths of the first generation that were confined in life-history cages during July and August, 1918, averaged fifteen days, with a maximum of twenty-four days and a minimum of six days (see Table V).

Second Generation.

The duration of fertility of 15 female moths of the second generation that were confined in life-history cages during May and June, 1918, averaged 13.66 days, with a maximum of twenty-one days and a minimum of six days (see Table XI).

The long period of fertility of the female moths in both generations of the European corn borer is important because it results in larvæ of several different instars being present in the same field, and often on the same plant at the same time. This may be an important consideration in any control measures that have for their object the destruction of the young larvæ before they enter the plant.

The long period of fertility also increases the chances that gravid females may start new infestations of the insect by being carried outside of the infested area.

PARASITES.

EUROPEAN RECORDS OF PARASITES.

European literature contains very few records of parasites bred from the European corn borer in any of its stages. Most of the literature on this species emphasizes the absence of any parasites.

Robin and Laboulbene (11) mention the fact that one of their colleagues, M. Jules Fallon, reared many specimens of *P. nubilalis* (Botys) from larvæ to adults during several consecutive years prior to 1879, but secured no parasites, either hymenopterous or dipterous, from any stage of the insect.

Jablonowski (16) records breeding a parasite fly, *Ceromasia interrupta* Rdi., from the larva of *P. nubilalis*. The author states that "the insect is not much infested by parasites in Hungary."

Kollar (6) mentions that some Ichneumonidæ have been bred from the insect.

RECORDS OF PARASITES IN MASSACHUSETTS.

No parasites were bred from the egg of the European corn borer during the investigations in Massachusetts.

Parasites of the Larva.

In Massachusetts four different species of dipterous parasites belonging to the Tachinidæ have been bred from larvæ of the borer. These Tachinids were determined by Dr. J. M. Aldrich of the United States National Museum as *Masicera myoidea* Desv., *Exorista pyste* Walk., *Exorista nigripalpis* Tns., and *Phorocera erecta* Coq. No other parasites were bred from *P. nubilalis* larvæ.

In each of the species noted above the parasite larva emerged from its host larva just previous to normal pupation of the latter. All of these records were secured from host larvæ collected in the field and kept under observation in cages. During the progress of dissecting infested plants in the field, occasional parasitic dipterous larvæ and puparia were found in the tunnels of *P. nubilalis*. In these instances it was not possible to state definitely whether the parasite had emerged from *P. nubilalis*, or from some other larva which had wandered into the *P. nubilalis* tunnels.

For this reason these records are not included among the list of *P. nubilalis* parasites.

Only a small per cent of *P. nubilalis* larvæ were parasitized. During the entire season of 1918 a total of about twenty individual dipterous (Tachinid) parasites were bred, although several hundred larvæ were under observation in life-history cages and in the process of securing other biological data. The highest percentage of parasitism recorded was from a collection of 50 full-grown *P. nubilalis* larvæ dissected from the stalks in a badly infested field in Revere, Mass., on Aug. 23, 1918. Two parasitic larvæ emerged from the total of 50 *P. nubilalis* larvæ, a percentage of parasitism of 4.

A fact worthy of recording here is that during July, 1918, the larvæ of *Papaipema nitela* Gn. were very highly parasitized by *Masicera myoidea* Desv. The larvæ of *P. nitela* were tunneling through the same plant, or plants in the same hill, as larvæ of *P. nubilalis*, and the latter were only parasitized to a very small extent by the Tachinid. The statement has been made by foreign observers that one reason for the dearth of larval parasitism in *P. nubilalis* is their protected mode of living within the plant, but in the instance recorded it would seem as though *P. nubilalis* should have been parasitized to as great an extent as *P. nitela*, which at this time was following the same mode of attacking its host plant.

Parasites of the Pupa.

In Massachusetts two different species of hymenopterous parasites have been bred from pupæ of the European corn borer. These were determined by Mr. A. B. Gahan of the United States National Museum as (*Pimpla*) *Epiurus pterophori* Ashm., and (*Ichneumon*) *Amblyteles brevicinctor* Say.

The hymenopterous larva of *E. pterophori* was found feeding on the internal juices of a *P. nubilalis* pupa which had been broken open. The full-grown parasite larva spun a brown silken cocoon and pupated within the remains of its host. Only two of these parasites were bred.

The adult parasite *A. brevicinctor* emerged from the fully formed pupa of *P. nubilalis*. Two of these parasites were bred during August, 1918.

No other definite records of pupal parasitism were secured, although several hundred pupæ were under observation in life-history cages and during the progress of securing other biological data.

A single adult specimen of *Agrypon* sp. (det. Gahan) was found in a pasteboard box cage which contained about a dozen discarded *P. nubilalis* pupæ. The head cap of one of these had been forced off, so it is probable that the parasite emerged from this pupa. This cannot be considered a definite record of *P. nubilalis* parasitism, however.

A single specimen of *Macrocentrus* sp. (det. Gahan) was bred from a hymenopterous cocoon found in the tunnels of *P. nubilalis*, near the remains of a *P. nubilalis* pupa; but this also cannot be considered a definite record of *P. nubilalis* parasitism.

Summarizing the records of parasites bred from the European corn borer it will be noted that there are four species of Diptera and two species of Hymenoptera represented. The number of different species attacking *P. nubilalis* suggests the possibility that parasites may in the future have some influence in controlling the pest, but at the present time they cannot be relied upon to accomplish much.

PREDATORS.

BIRDS.

Several species of birds, including woodpeckers, blackbirds and crows, have been observed to feed upon the larvæ and pupæ of the European corn borer. Blackbirds have been observed to pick them out of infested corn tassel-stalks, frequently breaking over the tassel-stalk to reach the insect within. On one occasion a flock of crows settled down in an infested patch of field corn and devoured nearly all of the *P. nubilalis* larvæ which were feeding on the ears. Incidentally they also devoured some of the corn.

INSECTS.

Larvæ of the corn ear worm *Chloridea obsoleta* Fab. frequently kill and feed upon *P. nubilalis* larvæ which are feeding on the same ear of corn.

A small beetle, *Ips fasciatus*, is frequently found in *P. nubilalis* tunnels but has not been observed to prey upon the larva of the pest.

CONTROL.

DESTROYING PLANTS CONTAINING OVERWINTERING LARVÆ.

Bearing in mind the life history and habits of the European corn borer, it is evident that any measures for controlling the insect must be preventive rather than remedial. The most obvious method of preventing damage by the insect, or at least greatly reducing its numbers, is by the destruction of plants containing the overwintering larvæ. This may be accomplished any time during the period from the middle of October until the middle of the following May.

Burning Infested Plants.

Burning infested plants is undoubtedly the most practical and effective measure that can be adopted for the destruction of the overwintering larvæ. At first thought this seems to be an easy method of handling the problem, but when the great variety of food plants is considered, and also the extent of the infested area (320 square miles), it becomes one of great proportions. In order to destroy the larvæ in any given area by this method, all parts of the different food plants within that area must be burned, including the roots or stubble of the plants.

In comparatively large areas occupied by weeds this result may be accomplished by a running fire which, under favorable conditions, will effectively burn all plants to the surface of the ground, and kill any larvæ that may be present in the roots.

In the infinite number of small areas present throughout the infested region, and especially in the vicinity of buildings, it is not generally possible to start or maintain a running fire, and, under these circumstances, it becomes necessary to remove the infested plants and burn them in piles or in some receptacle provided for the purpose. This method entails considerable labor and expense, and when applied to the 320 square miles infested, presents a large problem.

Cornstalks and other infested plants in cultivated areas may generally be cut very close to the ground and burned in piles. The stubble may then be plowed out, raked up and burned, if no better means for its destruction are available. In small areas of corn it is sometimes more practicable to pull up and burn the entire plant than to remove and destroy the stubble.

During the early fall of 1918 considerable difficulty was experienced in attempting to burn cornstalks and other infested plants, owing to the large amount of water still present in the stalks, some of these plants being still green in appearance and resisting all efforts to burn them, even when kerosene oil was applied. It is possible, therefore, that in some instances infested plants must be burned during the early spring or during mild periods of the winter. It is not necessary to entirely consume the infested plants in order to kill the larvæ contained therein, but these plants should at least be given a thorough scorching or be exposed to considerable heat.

While experimenting with methods for burning infested plants several different types of torches were used. None of these, however, gave any satisfaction during the fall of 1918. This result may have been due to the green condition of many infested plants on which the torches were used, and it is possible that this method may give better results during the winter and spring, when the infested plants are dead and dry.

It is hoped that ultimately some type of a portable burning apparatus will be developed for use in burning large quantities of infested plants easily and at a low cost.

Any method adopted for the burning of infested plants throughout the entire infested area will result in a considerable outlay of money. Nevertheless, it is believed that burning is the best method to use in clean-up operations. Figures, compiled from data concerning the towns in the area infested by the pest up to November, 1918, show that about 50,000 acres must be treated.

Burying Infested Plants.

Burying infested plants may destroy the contained larvæ under some conditions. This method of eliminating infested material is especially desirable from an agricultural viewpoint, because the decaying plants

provide humus so necessary to the maintenance of fertility and texture in the soil. If this method is adopted, however, the infested plants must be buried at least a foot in the soil, and the surface packed, if possible. Experiments to date have indicated that this method of destroying infested plants cannot be relied upon unless undertaken with great care.

In ordinary plowing operations infested plants are only partially turned under, and much of the plant remains are left on the surface of the ground. This is not an effective method for destroying infested plants.

During the month of May, 1918, infested cornstalks were buried in the soil to a depth of 6 inches, and in a manner resembling the work of an ordinary plow. The second generation larvæ contained in these buried stalks promptly made their way to the surface of the soil and entered plant remnants in the vicinity. Different results might possibly have been secured if the infested stalks had been buried in the fall and left in the soil through the winter, and experiments were started during the fall of 1918 to determine this point.

Infested cornstalks, buried to a depth of 12 inches in October, 1918, were dug up five weeks later and found to contain living larvæ. These were still actively feeding, although the interior of each cornstalk was soft and had begun to decay.

If a method could be developed for plowing under infested plants in order to destroy the larvæ contained therein it would be very desirable but in the present state of our knowledge concerning the matter this practice cannot be recommended.

Feeding of Infested Plants.

The feeding of infested plants to live stock is, from the economic viewpoint, the best possible means for destroying the larvæ of the European corn borer. The value of the stalks for fodder is not materially affected by the presence of the insects, and, if properly carried out, this method must result in the destruction of all insects within the infested plants. This is particularly true in the instance of infested corn fodder.

Shredding the corn fodder, or cutting it into small sections before feeding, greatly reduces the chance that any of the contained larvæ will survive. Live stock relish corn fodder when fed in this form, and will eat all parts of the plant.

Ensilage, by ordinary methods, effectively destroys all larvæ within the fodder, as the insects cannot survive the conditions existing in the silo.

Composting Infested Plants.

Whenever infested plants or parts of plants are placed in a compost or manure pile and covered deeply, the resulting decay and fermentation quickly result in the death of the larvæ contained within the plants.

It is a common practice on some farms to use corn fodder for bedding. This corn fodder ultimately becomes mixed with the manure, and any larvæ present in the corn fodder do not survive the treatment.

APPLICATION OF ARSENICALS TO PLANTS.

Although much of the literature dealing with the habits of the European corn borer emphasizes the fact that the larva feeds entirely within the plant, close observation of the habits of the insect has shown that a large proportion of the first and second instar larvæ feed almost exclusively on the upper and lower leaf epidermis of some of their host plants. This circumstance at once suggests the possibility of control by the application of arsenical poisons, and experiments were attempted during the summer of 1918 in order to determine this point.

Dusting with Lead Arsenate.

An application of powdered lead arsenate was made on June 24, 1918, to 60 hills of sweet corn growing in the experimental plot at West Medford, Mass. At this time most of the corn borer larvæ were feeding on the leaf epidermis or on the staminate flowers of the tassel. An attempt was made to get the poison into the unfolding tassel and around the bases of the corn blades, as well as to cover the surface of the leaf blades. This treatment did not noticeably curtail the activities of the larvæ. When the ears developed they were infested in the same proportion as the check rows.

Other Dusting Experiments.

Calcium arsenate powder and equal parts of calcium arsenate powder and hydrated lime were applied in the same manner as arsenate of lead. The results were the same, although calcium arsenate appeared to be more effective than any of the other arsenical powders used. The check rows used in the calcium arsenate experiment were noticeably infested to a greater degree than the treated row. All the ears in the treated row were at least somewhat infested, however.

Spraying with Lead Arsenate.

Three applications of lead arsenate, at the rate of 1 ounce of the powder in 2 gallons of water, were made to 32 hills of sweet corn on Aug. 5, 13 and 22, 1918. Daily observations were made of these corn plants, and an effort was made to apply the poison at a time when it would be most effective in covering the surface areas of the plant that was being eaten by the larvæ of the borer.

At the time of application the poison spray adhered to the foliage very well, and the excess liquid ran down the leaf blades and collected at the bases of the tassels and leaf blades, these points being the favorite feeding places of the young larvæ.

When the ears developed in this plot a close examination showed that 211 ears were present, of which the entire number were infested. Many

of these ears were only damaged to a slight degree, however, and in general were in a much better condition than those in the check rows.

About 52 per cent of the tassels were broken over in the sprayed plot while 61 per cent were broken over in the check rows.

The stalks of the sprayed plants were all infested by the pest, but surface feeding had been entirely prevented. The sprayed plants had a much better (greener) color than the plants in the check rows. Late in October most of the plants in the check rows had fallen over as a result of *P. nubilalis* attack, but only about 10 per cent of the sprayed plants had done this.

The results of this experiment indicate that many of the European corn borer larvæ can be killed by the application of arsenicals at the right time, but that the damage to the plants by the insect cannot be prevented to a paying degree.

Corn grows very rapidly throughout the period when spraying is necessary, and the newly developed portions of the plant are the favorite points of attack, viz., bases of the leaf sheath, surface of the leaf blade, and the tassel. This necessitates frequent sprayings in order to combat the larvæ of the pest, which hatch over quite an extended period of time. The cost of spraying large areas would, therefore, be probably prohibitive.

Spraying with Calcium Arsenate.

Three applications of calcium arsenate, at the rate of one-half ounce of the powder to 2 gallons of water, were made on the same date and in the same manner as have been detailed for lead arsenate. The results were practically the same, although calcium arsenate appeared to be more satisfactory in its prevention of injury than did lead arsenate.

CULTURAL PRACTICES TO AVOID DAMAGE.

Several observations made during the summer of 1918 seemed to suggest the possibility that damage by the borer could be avoided by regulating the time of planting corn so that the plants would not be at a stage to attract the female moths of the insect during their time of activity. The female moths prefer to deposit their eggs upon some plant bearing a soft, green seed head. If corn plants bearing a tassel are not available the females habitually deposit their eggs upon some other species of host plant that bears a seed head in the desired stage of development.

It was observed that adjoining corn fields, in different stages of development, were often infested in varying degrees by the insect. In one market garden at West Medford, Mass., a field of sweet corn, planted on April 1, 1918, was very severely infested by the borer. An adjoining field of sweet corn, planted about April 10, 1918, was only infested to a moderate degree. A third field of sweet corn, planted about April 30, 1918, was practically free from the pest, and an examination of the ears when harvested showed only a very small per cent of injury.

OTHER INSECTS FREQUENTLY MISTAKEN FOR THE EUROPEAN CORN BORER.

THE STALK BORER.

The stalk borer *Papaipema nitela* Gn. is frequently mistaken for the European corn borer. *P. nitela* attacks and tunnels in the stalks of a great variety of plants, including corn, tomatoes, potatoes and many other wild and cultivated plants. During the spring and early summer the larva is quite commonly found in the same field and often in the same plant with the European corn borer, but it may be distinguished from the latter during its early stages by the presence of a wide transverse brown band extending around the middle of the body. When nearly full grown the *P. nitela* larva more closely resembles *P. nubilalis*, but may be easily distinguished from the latter at that time by the absence of the short stout spines which arise from the light-colored abdominal areas of *P. nubilalis*, and by the uniformly greater length and breadth of the *P. nitela* larva. Another point of difference between the two species is that *P. nubilalis* pupates within its larval tunnels, while *P. nitela* leaves its host, when full grown, and pupates in the soil. In corn the larval tunnels of the two species are quite often similar, but the tunnels of *P. nubilalis* are generally packed with a light colored frass, and in some instances contain the empty pupal skin, while the larval tunnels of *P. nitela* are generally free from frass, or, if present, the frass is much darker and composed of larger particles than that of *P. nubilalis*.

Many reports of *P. nubilalis* injury have been found, upon investigation, to have for their basis the injury caused by *P. nitela*.

THE CORN EAR WORM.

Larvæ of the corn ear worm *Chloridea obsoleta* Fab. are sometimes mistaken for those of the European corn borer. The larvæ of the first-named species are frequently found feeding on the same ear of corn with larvæ of *P. nubilalis*, but may be easily distinguished from the latter by the presence of varicolored stripes running lengthwise of the body, and by the fact that larvæ of the corn ear worm, as the name implies, confine their operations, when feeding on corn, almost exclusively to the kernels of the ear, and do not enter the cob or the stalk. They may generally be found feeding on the surface of immature ears.

CUTWORMS.

Several species of cutworms are occasionally found feeding on the ears of corn, but may be distinguished from larvæ of the European corn borer by the same characteristics as have been mentioned in the instance of the corn ear worm.

SUMMARY.

The European corn borer has recently become established in the eastern part of Massachusetts. This pest has long been recorded in Europe and Asia as one of the most serious insect enemies of corn, hemp, millet, hops and other crops. It was probably introduced into Massachusetts through the importation from Europe of raw hemp for use in cordage factories, about the year 1910.

The insect was first discovered in Massachusetts in the summer of 1917. At that time it was causing severe damage to sweet corn and other plants. Preliminary investigations indicated that the insect had become established over an area of about 100 square miles immediately north and northeast of the city of Boston, and that the serious nature of the pest called for prompt and vigorous action by both State and Federal authorities if the corn crop of the country was to be safeguarded.

During the season of 1918 the Massachusetts Agricultural Experiment Station and the United States Bureau of Entomology co-operated in a further investigation of the insect, in order to obtain detailed information concerning its distribution, habits and food plants, with a view to instituting quarantine and control measures that would confine the pest to its present area and lead to its ultimate control.

As a result of these investigations it was determined that up to November, 1918, the European corn borer had established itself in an area of about 320 square miles, comprising 34 towns, located immediately west, north and northwest of the city of Boston.

The insect attacks a great variety of both wild and cultivated plants, including sweet corn, field corn, fodder corn, timothy, oats, celery, tomatoes, potatoes, beans, beets, Swiss chard, chrysanthemums, dahlias, gladioli and many of the larger weeds and grasses.

Corn is its favorite food plant, however, and is injured by the pest to a greater extent than any of its other host plants. All parts of the corn plant are attacked, except the fibrous roots. The economic injury to corn consists of the following: (1) injury to tassel which results in poor fertilization; (2) injury to stalk which reduces vitality of plant; (3) injury to stalk which causes breaking over of plant; (4) injury to stalk which indirectly affects the ear by cutting off its supply of nutriment; (5) injury to ear which directly affects the yield; (6) injury to the silk of the ear which results in poor fertilization.

A maximum of 117 full-grown European corn borer larvæ have been taken from one corn plant and 311 full-grown larvæ were dissected from a single hill of corn containing four plants. The average number of larvæ dissected from 75 corn plants, taken at random in the same field, was 46. This is at the rate of 1,050,640 larvæ per acre of corn. As many as 15 were found attacking a single ear of sweet corn.

Field counts made in infested corn fields showed that frequently as high as 100 per cent of the ears were infested.

The other economic plants mentioned as hosts of the European corn borer are attacked by the insect only in the absence of corn, or as a result of their nearness to corn in badly infested fields.

The wild plants mentioned as hosts of the insects are attacked only in the absence of corn, and are not economically important except that they serve as intermediate hosts for the multiplication of the pest.

There are two generations of the insect each year. The nearly full-grown second generation larvæ pass the winter in a dormant condition within their tunnels, and resume feeding with the approach of warm weather in the spring. They pupate about the middle of May. The pupal period lasts about seventeen days, and the moths emerge the first week of June to deposit eggs for the first generation. A maximum number of 727 eggs was deposited by a single second generation female in life-history cages, and the average number deposited by a single female was 337 eggs. These eggs are deposited in masses from 5 to about 50 eggs, on the under sides of the leaves of the host plant. The first generation larvæ hatch in about seven days and reach their full growth in about forty-four days. They pupate within their larval tunnels, and the pupal period lasts about nine days. The moths emerge about the middle of July and deposit eggs for the second generation. A maximum number of 903 eggs was deposited by a single first generation female in life-history cages, with an average number per female of 545 eggs. The second generation larvæ hatch in about six days and are nearly full grown by winter.

Four species of dipterous parasites were bred from the larvæ of the European corn borer, and two species of hymenopterous parasites were bred from the pupæ. No parasites were bred from the egg. The percentage of parasitism by any of these species is very small, and at the present time they cannot be relied upon to hold the pest in check.

Burning the plants containing the overwintering larvæ, any time during the period from the middle of October to the middle of the next May, is the most effective control method now known. Other methods, applicable under certain conditions, for destroying infested plants are placing in manure or compost; in a silo; burying deeply in the soil; or feeding directly to live stock, preferably shredded or chopped finely. Spraying infested corn plants with arsenicals in order to kill the young larvæ feeding on the surface of the plant was not found to be practical, owing to the number of sprayings necessary to keep the growing plant covered with the arsenical, and to the fact that the small per cent of larvæ not killed by the arsenical was sufficient to generally ruin the ears of corn for commercial purposes. Cultural practices may aid in avoiding damage by timing the planting of corn in such a manner that the plants may not be at a stage of growth which attracts the female moths during their period of oviposition. The female moths prefer to deposit their eggs upon some plant bearing a soft green seed head. If corn plants bearing a tassel are not available the females habitually deposit their eggs upon some other kind of host plant.

In October, 1918, a Federal quarantine was established prohibiting the interstate movement of corn fodder, cornstalks, green sweet corn, roasting ears, corn on the cob and corn cobs from the towns known to be infested by the European corn borer.

In August, 1918, the State of Vermont issued a quarantine order prohibiting the movement of all stalks or ears of the corn plant, either green or dried, from the State of Massachusetts into the State of Vermont. A similar quarantine has been established by Connecticut.

During the spring of 1918 a campaign was inaugurated by the Massachusetts State Board of Agriculture for the destruction of all infested plants within the infested area. This resulted in greatly curtailing the activities of the insect during the following season. In October, 1918, this campaign was resumed under the joint auspices of the Massachusetts State Department of Agriculture and the United States Bureau of Entomology, Division of Cereal and Forage Insect Investigations.

Owing to the open winter of 1918-19 a continuation of the clean-up work was possible to a greater extent than was expected. This, after Dec. 1, 1918, was done mainly with funds provided by the United States Bureau of Entomology.

Since the preparation of this bulletin the European corn borer has been found over an area of about 400 square miles near Schenectady, N. Y.

To avoid any possible confusion as to responsibility for the material contained in this bulletin, it should be stated that the sections on Geographical Distribution, Quarantine Measures, Insects frequently mistaken for the Corn Borer, the Introduction, and the Summary were supplied by Mr. Caffrey. The observations under the heads of History in the United States, Food Plants, Life History, Habits, and the others were made by Mr. Vinal; the descriptions of the different stages were the result of examination of specimens by Messrs. Vinal, Caffrey and Fernald.

LITERATURE.

[References cited are indicated by numbers in parentheses.]

- (1) *Ph. lupulina* Clerck, Icones Insectorum rariorum, Sect. I, IX, 4, 1759 (wrongly considered as *nubilalis* by Guenée (7)).
- (2) *Pyralis Nubilalis* Hübn., Eur. Schmett., Sechste Horde, 25, 14: Pyralides XIV, 94, 1796. ♂.
Pyralis Silacealis Hübn., Eur. Schmett., Sechste Horde, 25, 15: Pyralides XVIII, 116, 1796. ♀.
- (3) *Pyralis Glabralis* Haw., Lep. Brit., 379, 1811.
- (4) *Pyralis Silacealis* Treits., Schmett. v. Eur., VII, 81, 1829.
- (5) *Pyralis Silacealis* Dup., Hist. nat. des Lep., VIII, 121: CCXVII, 4, 1831.
- (6) *Botys (Pyralis) silacealis* Koll., Treat. on Inj. Ins., 108, 1840.
Botys silacealis H. S., Syst. Bearbeit. der Schmett. Eur., IV, 30, 1849.
- (7) *Botys Lupulinalis* Guen., Delt. et Pyr., VIII, 331, 1854.
- (8) *Botys Zealis* Guen., Delt. et Pyr., VIII, 332, 1854.
- (9) *Botys nubilalis* Led., Wien Ent. Monats., VII, 372, 1863.
Botys lupulina Hein., Schmett. Deuts. u. d. Schweiz, I, 2, 70, 1865 (wrong identification).
- (10) *Botys nubilalis* Staud. and Wocke, Cat. Lep. Eur., II, 209, 1871.
Botys silacealis Snell, Die Vlind. van Ned., II, 49, 1882.
Botys nubilalis Jourdeuille, Mem. Soc. Acad. de l'Aube (3), XX, 129, 1883.
- (11) *Botys nubilalis* Robin and Laboulbene, Ann. Soc. Ent. France (VI), IV, 5-17, 1884.
Botys nubilalis Leech, Brit. Pyralides, 32, IV, 4, 1886.
- (12) *Hapalia kasmirica* Moore, Desc. New Ind. Lep. Coll. Atk., 222, VII, 28, 1888.
- (13) *Hapalia eupulina* Butler, Ill. Het., VII, 19, 1889.
- (14) *Pyrausta nubilalis* Meyrick, Handb. Brit. Lep., 416, 1895.
- (15) *Pyrausta nubilalis* Hamp., Fauna of Brit. India, IV, 435, 1896.
Pyrausta nubilalis Hamp., Proc. Zoöl. Soc., Lond., 259, 1899.
- (16) *Botys nubilalis* Jablonowski, Rovartani Lapok, IV, 10-164, 1899. Review by Aigner-Abafi in Ill. Zeits. f. Ent., V, 125, 1900.
- (17) *Pyrausta Nubilalis* Staud. and Rebel, Cat. Palearc. Lep., II, 65, 1901.
Pyrausta nubilalis Pierce, Man. Dangerous Ins. likely to be Introduced in U. S., 123, 1917.
- (18) *Pyrausta nubilalis* Vinal, Bull. 178, Mass. Agr. Exp. Station, December, 1917.

EXPLANATION OF PLATES.

All except Figs. 12, 13 and 14 drawn from sketches by R. E. Snodgrass.

PLATE I.

- FIG. 1. — First larval instar.
- FIG. 2. — Second larval instar.
- FIG. 3. — Prothoracic shield of first two instars.
- FIG. 4. — Third larval instar.
- FIG. 5. — Prothoracic shield of third instar; spines not shown.
- FIG. 6. — Fourth larval instar.
- FIG. 7. — Prothoracic shield of fourth instar; spines not shown.

PLATE II.

- FIG. 8. — Fifth larval instar.
- FIG. 9. — Prothoracic shield of fifth instar.
- FIG. 10. — Sixth larval instar.
- FIG. 11. — Prothoracic shield of sixth instar.
- FIG. 12. — Venation of fore wing of adult.
- FIG. 13. — Venation of hind wing of adult male.
- FIG. 14. — Frenulum of hind wing of female.

PLATE I.

Fig. 1

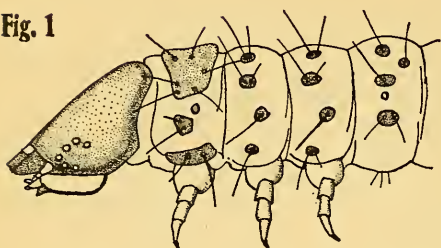


Fig. 3



Fig. 2



Fig. 4

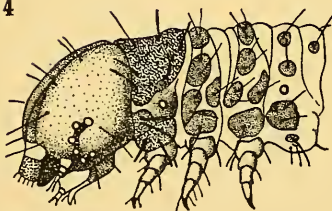


Fig. 5



Fig. 6

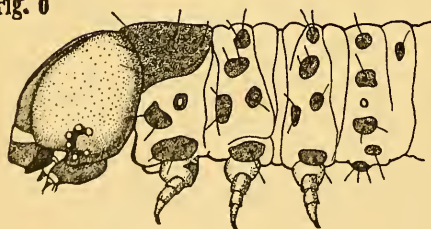


Fig. 7



PLATE II.

Fig. 8

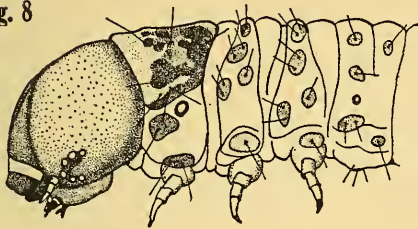


Fig. 9

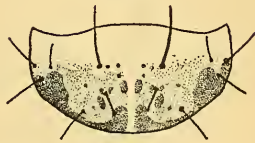


Fig. 10



Fig. 11



Fig. 12

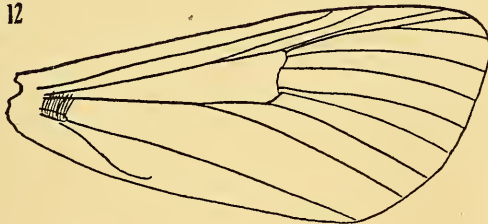


Fig. 13

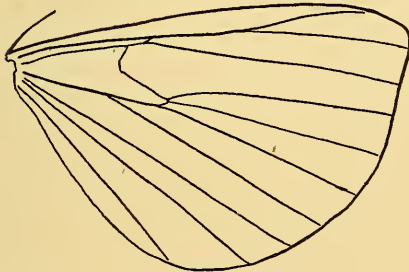


Fig. 14



BULLETIN No. 190.

DEPARTMENT OF HORTICULTURE.

THE PROPAGATION OF APPLE TREES ON THEIR OWN ROOTS.

BY J. K. SHAW.

INTRODUCTION.

The methods of propagation of tree fruits in common use among nurserymen produce trees the trunk and crown of which are of the variety desired, while a part or the whole of the root system is of seedling origin. In many cases roots are thrown out from the base of the scion that are, of course, of the variety of the aerial part of the tree, but it is doubtless true that in most cases, especially with budded trees, the seedling forms the greater part, if not the whole, of the root system. This means that in any orchard of any one variety there is a great deal of variation in the root systems. No two are of identical constitution. This is due to the complexity of the genetic constitution of our cultivated varieties of apples. Seedlings of a single variety, even if from self-fertilized seed, show great variation and many different combinations of characters.

It is reasonable to suppose that these differing seedling roots should cause more or less modification of the top, and there is abundant evidence that this is the case. The most common example is found in dwarf trees. There are many types of the common apple that, when used as stocks, inhibit the growth of the scion, and those that will throw out roots from the stem readily are used as dwarfing stocks. It is well known that dwarf stocks influence also the size, color, quality and season of maturity of the fruit. It is therefore reasonable to believe that many of the individual differences among the trees in an orchard may be due to the varying seedling root systems, and such individual differences, especially in productiveness, are greater than is generally realized. If trees could be propagated on their own roots, or on the roots of a clonal variety known to be well suited to the scion variety, much might be gained in uniformity and fruitfulness in the orchard.

Another advantage in having trees grafted on roots of known varieties lies in the greater resistance to insects and diseases of the roots that can be secured in this way. This idea is in practical use in Australia and South Africa, where the method is used to avoid serious trouble with the root form of the woolly aphis. This insect was early imported from America, and is there known as the American blight. It was found that Northern Spy roots were highly resistant to this insect, and it is now the usual practice in those countries to propagate all varieties on roots of the Northern Spy, or some other resistant variety.¹

It has been the observation of the writer that roots of different varieties differ in their susceptibility to crown gall, and it is reasonable to suppose that the same may be true with other root diseases. Root troubles are the cause of failure of bearing trees more often than is generally realized. Propagating varieties on known roots offers a chance of overcoming, to a considerable degree, at least, many of these root troubles.

In the northern part of the apple belt, especially in the prairie northwest, resistance of the roots to extreme cold becomes important, and it is considered highly desirable to get varieties on their own roots in order to avoid root killing in winter, when the temperature of the soil falls to an extremely low point. If trees of the varieties suited to these conditions could be worked on roots known to be of extreme hardiness, it would contribute to the longevity and consequent fruitfulness of the orchards.

If we concede that trees growing on roots of known varieties, either as own-rooted trees or trees on roots of other known varieties, may be more desirable for orchard purposes than trees on miscellaneous unknown seedling roots, there are suggested many problems for investigation. For example, what varieties on their own roots are resistant to the various insects and diseases, and what ones possess extreme hardiness to severe cold? What is the effect of different varieties used as root systems on the growth and fruitfulness of the scion variety?

Before these problems can be solved it is necessary to propagate trees on their own roots. The general question of the interrelation of stock and scion is under investigation at this station, and it is the purpose of this paper to set forth some of the results obtained in propagating trees on the roots of known varieties.

The first step in securing trees on known roots is to induce the formation of roots from the stem of the chosen variety. The methods most used in practice are by cuttings and by layers. It is known that apple wood roots from cuttings with the greatest difficulty, and that only certain varieties root readily by the somewhat slow and cumbersome method of layers. The method of growing trees on Northern Spy roots to secure resistance to the woolly aphis may be termed the nurse-root method. In this method a rather long scion is grafted by any appropriate method on a short piece of seedling root, and planted out in the usual way. Roots arise from the Spy scion, and the seedling nurse root may be removed, leaving the tree on its own roots.

¹ Cole, C. F.: Jour. Agr. Victoria, 9: 335 (1911).

PROPAGATION BY CUTTINGS.

There are few published records of attempts to propagate apple trees by cuttings. Doubtless many have been made and not reported, for the uniform results on record may be described in the single word — failure.

Luke¹ attempted to root apple cuttings of various sizes and lengths at cutting-bed temperatures of 64° and 67°. All failed to strike root. Luke was able to induce root cuttings to grow with fairly good success.

Attempts to root apple cuttings were made during the summer of 1912. Green wood cuttings 3 to 4 inches long were made in early August and September, and set in sand in the greenhouse. Powdered charcoal was also used as a propagating medium, both alone and as a one-half inch layer over sand, with the hope that it might check disease. Bottom heat in varying degrees was used in some cases, also an enclosed propagating frame. In short, an effort was made to provide the best possible conditions for cuttings. Something over a thousand cuttings of several different varieties were made. The results were much the same in all cases. The cuttings formed a callus, varying somewhat with the variety, and the buds started out until the leaves were about one-fourth inch long. This occupied about two weeks, after which growth ceased. The final result was the same in practically all cases. Of the 1,000 or more cuttings only a single one of the Fall Pippin variety rooted, and that only a single short shoot that was broken off in removing from the sand, so that it failed to grow. Fig. 1 is a typical representation of the range of development of callus and leaf. Arranged in order of callus development the varieties are Yellow Transparent, Fall Pippin, Red Astrachan, Bough (Sweet), Ben Davis, Wagener. As will be shown later, these varieties may be induced to root from the scion, when grown by the nurse-root method, more or less readily, according to the variety. There is, however, little or no correlation between callus growth and root formation, as may be seen by comparison with the numbers rooting shown in Table 2.

One lot of cuttings was watered with a nutrient solution, using a formula in common use for growing seedlings. The only effect was a noticeable growth of green algæ over the surface of the sand. The cutting growth was hindered rather than helped.

In spite of these failures it is the opinion of the writer that it is possible to grow apple trees from cuttings. To an inquiry addressed to many of the leading nurserymen of the country, thirty-five replied that they had never seen cuttings or prunings from the trees taking root, while seventeen professed to have observed such an occurrence, though none of them considered it at all common. One nurseryman reported having planted well-callused scions in a mixture of sand and soil, and that "the best stand we ever had was something less than 10 per cent of the cuttings planted." The trees were weak for a year or two. The late T. V. Munson

¹ Luke, F. K.: Proc. Columbus Hort. Soc., XIII: 95 (1898).

of Denison, Tex., says: "I have often had apple and even peach switches cut from the trees in February and stuck into the ground (very sandy) for label sticks, take root and grow off well."

In the spring of 1913 a considerable number of root cuttings from young trees were planted in the nursery row. No record was kept of them, but they made a good stand though growth was very slow the first season. It is the practice of at least one nursery firm to dig trees already established on their own roots once in two years and cut off the roots for propagation by root cuttings. The trees are then replanted and a new crop of roots grown.

In a later experience of the writer, root cuttings from the root system of bearing trees were used in an attempt to propagate the stock variety. This resulted in almost a complete failure. The roots used were from one-quarter to one-half inch in diameter, and when planted in the open, about 3 inches long. Others planted in the greenhouse were about 1½ inches long. Whether older roots propagate with greater difficulty, or whether some unfavorable conditions not readily seen interfered with success, cannot be told with certainty.

PROPAGATION BY LAYERS.

The method commonly used in propagating dwarf trees is by some form of layerage. A considerable number of attempts were made to induce root formation by air layerage. Earthen pots were split, and in early August were placed in appropriate position on growing shoots and filled with sphagnum moss. They were kept moist by frequent watering. None of these air layers showed root formation. It proved difficult with the rather small pots used to maintain uniform moisture conditions, and this may have had something to do with the failure.

In the spring of 1917 two-year-old trees growing in the nursery row were cut off 3 or 4 inches above the ground and allowed to stool. Later in the summer soil was heaped up around the new shoots to the height of 4 or 5 inches. The varieties used were Ben Davis, Bough, Rhode Island Greening and Transcendent. None of these shoots have been separated in an attempt to establish them as independent trees, but investigation in the spring of 1919 showed that most shoots of all these varieties bore small roots, coming out near the junction with the cut-off stump.

PROPAGATION BY THE NURSE-ROOT METHOD.

It is well known to most nurserymen that root-grafted trees often send out roots from the scion, and may eventually become established, partially, at least, on their own roots. In an attempt to collect information a questionnaire was sent to the leading nurserymen. About 75 replies were received, and most of these show care and thought in answering the questions. They were suggestive at the outset of this work, and are in-

teresting to review after eight years' work on the problem. The first question was, "Have you ever observed root-grafted apple trees rooting from the scion?" Fifty replies say yes, and 6 reply no. Especially in the Middle West nurserymen regard it as a common or usual thing, while in the East, South and on the Pacific coast it seems rather less well known. It may be that rooting is more frequent in the rich, loamy soil of the Middle West, or it may be that it is because the practice of root grafting prevails there more than in the eastern and other nursery regions.

The second question asked, "In what varieties, and in about what proportion of the trees," rooting from the scion had been observed to occur. The general trend of the replies was that all varieties might do so, Winesap being the only sort mentioned as not rooting. Generally the varieties mentioned were those most extensively grown. Ideas as to proportion of trees rooting were diverse, some saying a small percentage and others nearly all.

A question as to the most favorable conditions for rooting brought in nearly every case, when a positive reply was made, the suggestion of the long-scion, short-root graft; deep planting was often suggested; abundant fertility and plenty of moisture were often mentioned; where soil preference was expressed it was for a sandy or loamy soil.

METHODS USED.

The first lots of grafts for the purpose of securing trees on known roots were made in 1912, and others were made during subsequent years, including 1917. The method has been to make an ordinary piece root, whip graft, using a straight root 2 to 3 inches long, and a scion 6 to 8 inches long. The grafts have been made at various times in the late winter and early spring, most of them in February or early March. For the most part they have been made by student amateurs, and yet they have been as well made as the average of commercial work. It has appeared that there is more dependent on the way the scions were handled before and after grafting than in the skill with which the union was made. To test the necessity for large contact of the cambium layers five different methods or degrees of matching were tested, as follows:—

- (a) Matched on one side only, not at top or bottom.
- (b) Matched on both sides, not at top or bottom.
- (c) Matched at top, not at sides or bottom.
- (d) Matched at bottom, not at sides or top.
- (e) Perfectly matched all around.

The variety used was Baldwin.

Where it was desired to avoid matching, the scion or root was cut away, if necessary, to make a space of at least 1 millimeter. The grafts were then planted and cared for in the usual way. The results are shown in Table 1.

TABLE 1. — *Results of Various Methods of matching Cambium.*

	Number planted.	Per Cent growing.	Per Cent rooting from Scion.	Average Height of One-year Whips (Feet).
(a) Matched on one side, ...	45	80	8	3.2
(b) Matched on both sides, ...	44	65	24	4.1
(c) Matched at top, ...	45	42	39	3.8
(d) Matched at bottom, ...	45	66	19	3.0
(e) Matched all around, ...	45	60	36	3.4

These figures show no very consistent results. Evidently so far as the development of nursery trees is concerned, a small contact of the cambium layers is as good as a perfect fit. Nevertheless, it is quite possible that more extensive tests might reveal significant results.

In several cases grafts have been made in April and set immediately in the nursery row. Such lots have been somewhat slow in starting, but have given fully as good stands as those that had been stored for two months or more. Probably due in part, at least, to the slow start, they have made somewhat smaller trees at the end of one or two seasons' growth.

In some cases, storage has been in boxes packed in moss or other moisture-holding material. Sometimes this has seemed to be injurious, perhaps through the displacement of oxygen by carbon dioxide, and the grafts have failed to give a good stand, though starting well for the first week or ten days.

The planting has been done with a double or triple dibber made out of gas pipe or steel tubing. These tools enable one to plant the graft deep in the ground with only one or two buds showing. The earth has been pressed close to the graft by thrusting down a straight spade close to the graft, and tramping solidly with the feet.

In all cases the trees have been allowed to grow for two seasons. They make a small growth the first season, probably largely because of the small size of the nurse root. In most cases they have been cut back to the ground at the beginning of the second season, after which they make fairly strong one-year whips. Many of the trees have been budded the first summer, so that if they rooted from the scion we would have at the end of the second season the desired variety established on the root system of a named variety; for example, a Baldwin top on a Ben Davis root system. This method saves time, but owing to uncertainty of rooting from the scion it is not very satisfactory. When the trees are dug a record is made of those rooting and not rooting from the scion, and from the former the seedling root is cut. The point of union is always clearly

seen, and the only time a question arises is when a root appears just at the line of union. As a matter of safety in the main investigation, such trees have been counted as not rooted. After cutting away the seedling root the trees are replanted and budded during the summer if desired, and if they have not been already. At the end of one or two years we have a satisfactory tree established on its own roots or the roots of another named variety.

RELATION OF THE VARIETY TO ROOT FORMATION.

At the start of this work the sole purpose was to obtain trees on known roots for purposes of orchard and laboratory investigation of the interrelation of root and scion. It soon became evident that there were great varietal differences in the readiness with which roots were thrown out from the scion, and tests have been made of over 150 different varieties and species to measure their rooting ability. These tests have extended over a period of seven years. Some varieties have been tested only once, others two or more times, and some have been tested six times, and all in varying numbers, as shown in Table 2. Most of the scions have been taken from bearing trees or from those that have since come into bearing. A record has been kept of each lot separately, so that in a few cases, where the parent tree proved to be misnamed, the necessary correction has been simple. A few lots of scions were secured from nurseries; those were carefully examined for mixtures of varieties, and, so far as possible, compared with trees known to be true, and with printed descriptions. There is no more excuse for mixtures of trees in the nursery row than for mixtures of fruit in the barrel. All cases of doubtful identity have been thrown out, and it is thought that there is little chance of error in the varieties given in the table.

Individual lots of the same variety have differed widely in the percentage rooting, internal conditions in the scion or environmental conditions, or both, evidently playing an important rôle in root formation. Some of these will be discussed later.

TABLE 2. — *Varietal Differences in Root Formation.*

VARIETY.	Number grown.	Per Cent rooting.	VARIETY.	Number grown.	Per Cent. rooting.
Akin, ...	85	27	Golden Russet, . .	36	28
Alexander, . . .	48	21	Golden Sweet, . .	48	44
Anisim, ...	80	6	Gravenstein, . . .	100	55
Arctic, ...	97	19	Grimes, ...	83	41
Arkansas, . . .	35	77	Henry Clay, . . .	193	43
Arkansas Black, . .	45	44	Hibernal, ...	34	61
Bailey Sweet, . .	108	95	Hibkee, ...	13	34
Baldwin, ...	898	32	Horse (Yellow Horse), .	133	9
Ben Davis, . . .	627	51	Hubbardston, . .	947	21
Bethel, ...	137	0	Huntsman, ...	82	23
Bismark, ...	73	31	Hurlbut, ...	170	7
Black Gilliflower, . .	34	6	Ingram, ...	261	2
Blenheim, ...	54	35	Isham Sweet, . . .	81	2
Blue Pearmain, . .	82	24	Jacobs Sweet, . . .	28	4
Bonum, ...	206	14	Jefferis, ...	278	3
Bough (Sweet), . .	552	98	Jewett, ...	580	20
Canada Baldwin, . .	36	53	Jonathan, ...	175	11
Charlamoff, . . .	109	11	July, Fourth of, . .	55	62
Chenango, ...	89	69	Keswick, ...	121	56
Colorado Orange, . .	72	3	King David, . . .	29	22
Cox Orange, . . .	201	8	Kinnaird, ...	98	7
Deacon Jones, . . .	7	57	Lady, ...	160	3
Delicious, ...	131	22	Lady Sweet, ...	75	8
Dominie, ...	59	55	Lawver, ...	21	71
Dudley (North Star), .	17	70	Limber Twig, . . .	83	73
Early Harvest, . .	46	72	Longfield, ...	67	39
Early Melon, . . .	104	37	Lowland Raspberry, .	55	78
Early Ripe, . . .	58	29	Lowell, ...	90	8
Ensee, ...	162	6	Lowry, ...	260	13
Esopus Spitzenburg, .	69	79	Magnate, ...	174	3
Fallawater, . . .	15	67	Maiden Blush . . .	42	67
Fall Pippin, . . .	114	43	Malinda, ...	86	26
Fameuse, ...	56	80	Mann, ...	61	33
Gano, ...	51	63	McAfee, ...	22	27
Garden Royal, . . .	22	50	McIntosh, ...	208	74
Gideon, ...	57	40	McMahon, ...	35	29

TABLE 2 — *Concluded.*

VARIETY.	Number grown.	Per Cent. rooting.	VARIETY.	Number grown.	Per Cent. rooting.
Milding, ...	50	54	Scott Winter, ...	75	44
Milwaukee, ...	6	17	Shiawassee, ...	110	46
Minkler, ...	132	18	Silken Leaf, ...	10	40
Missouri Pippin, ...	99	41	Smith Cider, ...	167	14
Mother, ...	54	39	Smokehouse, ...	99	51
Newtown Pippin, ...	102	68	Stark, ...	47	43
Newtown Spitzenburg, . .	44	37	Stayman, ...	61	41
Northern Spy, ...	629	58	Stump, ...	81	30
Northwestern Greening, .	107	64	Summer Rambo, ...	99	13
Oldenburg, ...	958	25	Sutton, ...	32	34
Ontario, ...	87	53	Swaar, ...	136	32
Opalescent, ...	97	89	Tolman, ...	1,450	3
Ortley, ...	110	2	Tetofski, ...	85	3
Palmer Greening, ...	141	46	Tompkins King, ...	198	62
Paradise Winter Sweet, . .	114	2	Transcendent (Crab), . .	462	45
Paragon, ...	100	60	Twenty Ounce, ...	102	38
Patten Greening, ...	98	8	Wagener, ...	676	45
Peck Pleasant, ...	180	34	Wallbridge, ...	111	20
Pewaukee, ...	30	57	Walter Pease, ...	57	4
Plumb Cider, ...	98	19	Wealthy, ...	781	25
Porter, ...	265	6	Westfield, ...	103	83
Primate, ...	138	92	White Pearmain, ...	91	14
Pumpkin Sweet, ...	220	12	Williams, ...	240	30
Rambo, ...	94	32	Willow, ...	17	24
Ralls, ...	32	41	Wilson's June, ...	67	60
Red Astrachan, ...	601	67	Windsor, ...	277	2
Red Bietigheimer, ...	102	46	Winesap, ...	200	34
Red Canada, ...	54	2	Winter Banana, ...	166	48
Red June, ...	298	27	Winterstein, ...	105	9
Red Russet, ...	12	45	Winter St. Lawrence, . .	27	21
Rhode Island Greening, .	979	30	Wolf-River, ...	75	71
Ribston Pippin, ...	72	9	Wisner, ...	56	13
Rome Beauty, ...	66	9	Yellow Belleflower, . .	125	3
Roman Stem, ...	43	70	Yellow Transparent, . .	1,077	26
Roxbury Russet, ...	252	13	York Imperial, ...	57	23
Salome, ...	43	63			

Grafts have been made of twelve varieties of Siberian crab apples, but only those of Transcendent are reported in this paper, owing to some uncertainty in the correctness of the variety names. However, it may be said that they show a range in rooting percentages from zero to 96 per cent, being in this respect like the varieties of the common apple.

Tests have been made of a number of forms of our native apples. The names under which they were received and the sources were as follows:—

<i>Pyrus angustifolia</i> , ...	Arnold Arboretum, Boston, Mass.
<i>Pyrus coronarius</i> , ...	Arnold Arboretum, Boston, Mass.
<i>Pyrus coronarius</i> , ...	Prof. W. H. Chandler, Ithaca, N. Y.
<i>Malus coronarius</i> , ...	John Dunbar, Rochester, N. Y.
<i>Malus glaucescens</i> , ...	John Dunbar, Rochester, N. Y.
<i>Pyrus iowensis</i> , ...	Prof. L. Green, Ames, Iowa.
<i>Malus platycarpa</i> , ...	Arnold Arboretum, Boston, Mass.
<i>Pyrus iowensis</i> , ...	D. S. Lake, Shenandoah, Iowa.
Soulard Crab, ...	Prof. L. Green, Ames, Iowa.

These were grafted and planted in the usual manner and dug after two seasons' growth. The numbers varied from 5 to 104 of each form. No tree in the entire collection showed any signs of throwing out roots from the scion.

Trees of certain varieties failing to root from the scion during the seasons of 1915-16 were replanted in the spring of 1917. They were moderately strong whips, and were planted about a foot deep so as to cover several inches of the stem. The purpose was to secure additional trees on known roots, and to see if such trees would root more or less freely than newly made grafts. The results are shown in Table 3. The first column gives the number of trees replanted, and the second column the per cent rooting from the scion. For purposes of comparison the per cent rooting from the first planting of these varieties is given in the third column. Only in the case of Northern Spy is the percentage materially lower in the reset trees than in newly planted grafts. In most cases there is a materially higher proportion rooting from the scion. The replanting was on the same plot of ground. The difference may be due to more favorable weather conditions or other environmental causes, but it seems reasonable to suppose that the larger, stronger trees were better able to throw out roots. As a practical means of getting trees on their own roots by the nurse-root method, it would seem wise to replant those failing to root on the first trial.

TABLE 3. — *Reset Trees rooting in 1917-18.*

	Number planted.	Per Cent rooting.	Per Cent rooting from First Planting.
Baldwin, ...	18	39	39
Ben Davis, ...	9	56	39
Hubbardston, ...	74	22	23
Jewett, ...	52	27	14
Northern Spy, ...	10	40	52
Oldenburg, ...	62	52	21
Red Astrachan, ...	26	65	63
Rhode Island Greening, ...	18	44	31
Tolman, ...	132	19	6
Transcendent, ...	68	72	36
Wagener, ...	44	68	32
Wealthy, ...	24	54	21
Yellow Transparent, ...	82	48	17

EFFECT OF SOIL AND SEASON.

These experiments have continued over a period of seven years, new plantings being made in all but the seventh year. The six plantings have been on different plots, but all are similar in soil texture. The first lot grafted in 1912 was planted in part on experiment station land, while part were planted in a commercial nursery in Westfield, Mass. Later plantings were all at the experiment station. The number grown and per cent rooted from the scion at Amherst and Westfield are given in Table 4. These figures show no very consistent differences between the two locations. Where there are wide differences, one is below and the other above the average for the variety. Small numbers involved will account for many of the divergences in the proportion rooting from the scion. The soil in the two locations is similar, the Westfield location having a little less gravel and more fine sand and silt. Both would be called fine sandy loams.

TABLE 4. — *Trees grown at Amherst and Westfield in 1912-13.*

	AMHERST.		WESTFIELD.	
	Number planted.	Per Cent rooting.	Number planted.	Per Cent rooting.
Baldwin, ...	28	14	68	16
Ben Davis, ...	18	83	82	37
Bough (Sweet), ...	10	100	130	100
Hubbardston, ...	21	10	138	16
Northern Spy, ...	10	100	118	36
Oldenburg, ...	21	43	111	43
Red Astrachan, ...	22	36	106	55
Rhode Island Greening, ...	25	16	108	20
Tolman, ...	14	0	86	0
Wagener, ...	33	45	19	39
Wealthy, ...	22	14	51	51
Yellow Transparent, ...	23	17	52	40

Certain varieties called for by the plan for this investigation of the interrelation of stock and scion have been planted in all or nearly all of the six lots grown during the period of this investigation. Table 5 shows the percentages rooting from the scion in these lots. There is considerable variation from year to year in the different varieties, due, probably, to a variety of causes. As has been stated, a part of Series 1 was grown in Westfield, Mass., and the rest at Amherst. Series 2 was grown in Amherst adjoining Series 1, and under very similar soil conditions. Series 4 was on another adjoining plot and similar to the others, except that it contained a considerable amount of land that was rather wet. This did not visibly affect the growth of the trees, but may have interfered with root formation. Another portion failed to give a good stand of trees. This was given some special investigation without bringing to light any satisfactory reason for the poor growth. Series 3, 5 and 6 were grown in another field on plots not far apart and on similar soils. Like the other plots these were a fine sandy loam. Series 6 was grown on a plot a considerable portion of which was rather poorly drained, which may have been the cause wholly, or in part, of the poor rooting from the scion. The stand was good and the trees all made a fair growth. Series 5 was grown on well-drained soil and made a good growth. It is difficult to say why the general average of rooting is so low.

In Series 1 the varieties showing low percentages of rooting are generally those maturing growth rather late, while the early maturing varieties, such as Jewett, Oldenburg, Wealthy and Yellow Transparent, rooted better than in most other years. If this is significant it may mean that the scion contained a greater supply of stored food, due to conditions the previous season rather than any conditions during the two seasons while the tree was growing.

Taken as a whole, these figures show clearly the wide range of variation between different varieties, whatever are the conditions of growth of the scion before cutting, or of the graft. Bough roots in nearly every case, while Tolman roots in very few cases. The relatively high per cent of Tolman in Series 3 may be looked on as a chance variation due to small numbers.

TABLE 5. — *Trees rooting in Different Years.*

	SERIES 1, 1912-13.		SERIES 2, 1913-14.		SERIES 3, 1914-15.		SERIES 4, 1915-16.		SERIES 5, 1916-17.		SERIES 6, 1917-18.		Average.
	Number grown.	Per Cent rooting.	Number grown.	Per Cent rooting.	Number grown.	Per Cent rooting.	Number grown.	Per Cent rooting.	Number grown.	Per Cent rooting.	Number grown.	Per Cent rooting.	
Baldwin, ...	105	16	215	53	50	48	56	39	96	23	356	22	32
Ben Davis, ...	112	41	147	74	62	71	49	39	138	49	119	38	51
Bough (Sweet), ...	144	100	202	100	90	97	-	-	77	93	39	92	98
Hubbardston, ...	157	11	48	11	81	19	661	23	-	-	-	-	21
Jewett, ...	12	35	148	21	162	21	203	14	-	-	55	18	20
Northern Spy, ...	149	43	216	70	68	66	132	52	-	-	187	16	58
Oldenburg, ...	132	42	128	48	113	46	260	21	51	39	274	4	26
Red Astrachan, ...	113	42	128	91	61	97	169	63	-	-	130	52	67
Rhode Island Greening, ...	140	26	228	58	213	31	77	31	98	21	223	11	30
Tolman, ...	62	0	109	6	25	56	392	6	98	0	736	1	3
Wagener, ...	152	40	225	58	66	80	139	32	-	-	94	13	45
Wealthy, ...	77	39	138	44	122	20	107	21	49	22	188	2	25
Yellow Transparent, ...	64	38	201	66	236	46	222	17	-	-	418	5	26
Average per cent, ...	-	36	-	54	-	54	-	30	-	35	-	23	-

PIECE AND SIDE-ROOT GRAFTS.

It was suggested that side-root grafts might root better than those made in the usual manner of root grafts, and this was tried out, as shown in Table 6. Considerable pains were taken to get a reasonably good fit with the side-root grafts. It required more time to make them, and they were more inconvenient to plant. The root used was about 2 to 3 inches long, and the scion projected below the union about the same distance. As shown by Table 6, side-root grafts did root considerably better than whip grafts, but this gain was more than offset by the smaller proportion of the grafts growing. Of the whip grafts, 37 per cent of the number planted made own-rooted trees, while of the side grafts only 30 per cent showed roots from the scion. Therefore this test indicates no advantage of the side-root graft over the ordinary whip graft in establishing trees on their own roots.

TABLE 6. — *Piece and Side-root Grafts.*

	PIECE ROOT.			SIDE ROOT.		
	Total Number planted.	Per Cent growing.	Per Cent rooting.	Total Number planted.	Per Cent growing.	Per Cent rooting.
Baldwin, ...	529	55	47	173	55	67
Ben Davis, ...	284	69	77	124	50	60
Bough (Sweet), ...	244	82	100	110	44	100
Fall Pippin, ...	109	77	45	48	67	61
Jonathan, ...	162	79	21	74	24	71
Maiden Blush, ...	84	67	63	22	41	100
Ontario, ...	43	77	44	18	28	100
Pumpkin Sweet, ...	60	85	27	55	53	28
Primate, ...	61	72	100	41	32	100
Red Astrachan, ...	369	69	92	88	46	90
Rhode Island Greening, ...	359	70	55	149	26	62
Tolman, ...	80	78	11	96	40	0
Tompkins King, ...	149	76	91	38	71	92
Wealthy, ...	367	73	44	111	33	45
Williams, ...	168	77	40	24	22	100
Average per cent, ...	—	74	57	—	42	72

DWARF APPLE AND PEAR NURSE ROOTS.

Attention is frequently called to the fact that if dwarf apple trees are planted deep enough for the scion to be surrounded by soil it is likely to throw out roots, and the tree intended for a dwarf becomes a standard. To test whether scions worked on dwarf stocks would throw out roots more readily than those on crab stocks, several hundred grafts were made in the usual manner in Series 2 and 3, and the results are shown in Tables 7 and 8. The standard roots were mostly Kansas grown, while the two types of Paradise stocks were imported from France. It has been shown that there are several different types of Paradise, and just which types these were was not determined further than that the English Paradise was larger and stronger growing than the French Paradise stocks.

The data in Table 7 are not full enough to permit any definite comparison. The scions grew and rooted about as well on one stock as another.

Table 8 shows that in Series 2 the trees on dwarf stocks did not give as good a stand, but rooted better than those on standard stocks. Of the former, 43 per cent of the grafts planted gave own-rooted trees, and of the latter, 41 per cent rooted from the scion. The general conclusion is that dwarf roots offer no advantage over standard roots for growing own-rooted trees.

TABLE 7. — *Standard and Dwarf Roots.*

	STANDARD.			ENGLISH PARADISE.			FRENCH PARADISE.		
	Number planted.	Per Cent growing.	Per Cent rooting.	Number planted.	Per Cent growing.	Per Cent rooting.	Number planted.	Per Cent growing.	Per Cent rooting.
Baldwin, ...	257	27	63	168	18	19	-	-	-
Ben Davis, ...	283	22	77	130	29	63	-	-	-
Bough (Sweet), ...	188	32	100	172	51	95	-	-	-
Hubbardston, ...	-	-	-	163	25	22	105	46	16
Jewett, ...	211	42	25	-	-	-	160	76	30
Northern Spy, ...	-	-	-	101	41	53	61	64	77
Oldenburg, ...	316	33	48	50	20	60	179	20	36
Red Astrachan, ...	215	46	96	71	46	93	-	-	-
Rhode Island Greening, .	258	45	53	68	9	0	187	78	20
Transcendent, ...	168	15	85	187	17	65	-	-	-
Wagener, ...	155	32	83	106	15	100	73	56	79
Wealthy, ...	378	34	21	138	13	11	148	45	37
Yellow Transparent, . .	224	67	50	279	14	43	-	-	-

TABLE 8. — *Standard and French Paradise Roots.*

	STANDARD.			FRENCH PARADISE.		
	Number planted.	Per Cent growing.	Per Cent rooting.	Number planted.	Per Cent growing.	Per Cent rooting.
Ben Davis, ...	284	69	77	49	39	100
Bough (Sweet), ...	244	82	100	37	81	100
Rhode Island Greening, ...	359	70	55	54	35	70
Tompkins King, ...	149	76	91	47	57	67
Wealthy, ...	367	73	44	37	57	44
Average per cent, ...	—	74	55	—	54	76

At the outset of this work a number of grafts on the common French pear and on sand pear roots were made in addition to those on standard apple roots and some on English Paradise. It was thought that inasmuch as the pear roots would make but a poor growth, a greater number might root from the scion. Table 9 shows the number of grafts planted and the per cent growing in July following the planting. The grafts on both sand pear and French pear gave much poorer stands than those on standard or Paradise apple roots. Many of them perished before the time of digging at the end of the second summer, so that the records of the number rooting from the scion are too few and fragmentary to be worth presenting. The indications are that on both of the pear roots more trees rooted and had a stronger root system than on apple roots, but so few grafts grew that pear roots are not desirable for propagating apple trees on their own roots.

TABLE 9. — *Trees Growing on Apple and Pear Roots.*

	STANDARD APPLE.		PARADISE APPLE.		SAND PEAR.		FRENCH PEAR.	
	Number planted.	Per Cent growing.	Number planted.	Per Cent growing.	Number planted.	Per Cent growing.	Number planted.	Per Cent growing.
Arkansas, ...	50	76	—	—	25	22	24	8
Baldwin, ...	48	69	20	80	49	33	35	61
Ben Davis, ...	48	69	19	63	25	68	23	48
Bough (Sweet), ...	40	60	13	63	9	22	17	59
Gravenstein, ...	54	35	—	—	20	23	—	—
McIntosh, ...	75	60	9	78	17	32	—	—
Hubbardston, ...	50	54	15	73	22	23	—	—
Northern Spy, ...	35	51	28	89	50	28	40	25
Oldenburg, ...	52	46	15	24	—	—	25	22
Red Astrachan, ...	56	53	15	16	50	0	37	2
Rhode Island Greening, ...	51	61	20	50	30	12	12	0
Roxbury Russet, ...	50	84	15	67	—	—	22	23
Wagener, ...	50	76	15	87	36	28	25	40
Wealthy, ...	73	37	13	77	52	2	28	3
Williams, ...	41	24	15	24	—	—	—	—
Yellow Transparent, ...	44	65	20	49	40	25	25	8

EFFECT OF BUDDING ON ROOT FORMATION.

In order to save time in getting trees on known roots the earlier series of grafts were budded usually in August after planting. Then on digging, those that had formed roots from the scion were chosen for further work, and those failing to do so were rejected. Six top or bud varieties and fourteen stock or root varieties shown in Table 10 were used. The first column of figures in the table shows the rooting from the scion of the stock varieties, and these figures may be used as a standard for comparison. The other columns show the rooting of the stock varieties when budded with the six bud varieties. The figures in this table show great variation, but, on the whole, as shown by the averages at the bottom, Baldwin and Wagener tops have induced higher percentages of rooting than non-budded trees, while McIntosh, Tolman and Yellow Transparent lowered the percentage rooting. Red Astrachan caused no change.

It is questionable how much significance can be attached to these figures. In the case of the individual lots of budded trees the numbers involved are too few to place much dependence upon. In the case of the averages the numbers are, of course, greater, and it is fair to assume that Wagener buds, and more strikingly Baldwin buds grown during the second season of growth, may have, on the whole, favored root formation from these stock varieties.

GRAFTING ON KNOWN ROOTS.

Once trees are established on roots of known varieties it would seem a desirable process to dig such trees and cut off the greater part of the root system and replant them, that they may re-establish themselves on a renewed root system. Then the roots cut off may be used for grafting in the ordinary manner with scions of the same variety as the root. By this method own-rooted trees should be secured without resorting to the seedling nurse root, the subsequent removal of which is a severe check to the young tree, especially with those varieties that do not root freely.

This method was tried out in 1915-16. Trees were dug in the fall and all roots suitable for whip grafting removed and the trees reset, the tops being severely cut back. All recovered and in time became vigorous trees. The roots were stored in moist sand and grafted in February and set in April. For some reason they failed to make a good stand, and those that did grow made less growth than adjoining trees grafted in a similar manner on seedling roots. The number of grafts planted, and the percentages growing in July after planting and also in July a year later, are shown in Table 11. Seedling roots used in grafting are commonly one year old, while some of these roots were three or four years old, and this may have been responsible for the poor stand. The very fine sand in which the roots were stored was rather wet and compact, and this may have interfered with respiration and resulted in injury to the roots. It seems hardly reasonable to suppose that such poor results must necessarily follow grafting on the roots of known varieties.

TABLE 11. — *Grafts on Known Roots.*

	Number planted.	PER CENT GROWING.	
		July, 1916.	July, 1917.
Ben Davis, ...	56	39	23
Bough, ...	94	13	7
Northern Spy, ...	6	33	17
Red Astrachan, ...	144	14	6
Wagener, ...	65	12	5
Wealthy, ...	69	4	1

HISTOLOGY OF THE TWIG IN RELATION TO ROOT
FORMATION.¹

Roots on the scion usually arise near a bud, either singly or in twos or threes. No case has been observed when roots arose at a node opposite the bud. Roots may also arise from the internode, but generally within a half inch of the node. Generally they arise above rather than below the bud. The first indication of the root is the falling away of the axillary bud and the appearance of a swelling with two or three brownish white areas, — the growing points of the young roots.

Free rooting varieties develop roots early in the season. An examination of Bough grafts in July showed that they were rooting freely. At the same time Red Astrachan, Ben Davis and Tompkins King showed incipient root formation in a few cases, while poor rooting varieties showed no signs of roots. An examination about the middle of October showed progress in all these varieties, but the poorer rooting varieties showed hardly a tree with roots from the scion. Always, on digging, the poor rooting varieties have small roots (see Fig. 3) which have evidently formed the second season of growth.

If we examine a cross section of a one-year-old twig we find between the bark and wood the cambium, consisting of a layer of eight to fourteen very small, thin-walled rectangular cells. Measurements of the thickness of the cambium layer were made and the number of cells noted on a number of the varieties used. Measurements of the thickness of the bark were also made.

In choosing material, fresh twigs of the previous season's growth, from both bearing and nursery trees, were selected, and cross sections made usually at the fifth node back from the terminal bud. In the case of some immature tips it was necessary to go further back to secure a plump, mature bud. Sections were made with a sliding microtome and placed at once in 30 per cent alcohol for ten minutes. Then the alcohol was poured off and the sections stained for three to five minutes with Delafield's Hematoxylin, washed, mounted on the slide and measured at once. Measurements of the bark were to the wood, and included the cambium layer. They were made at a point one-fourth around the circumference of the twig from the bud when possible, and in all cases care was taken to avoid the thickened bark near the bud. The limits of the bark as thus defined were clear, but more difficulty was experienced in measuring the cambium layer because of a less clear differentiation between it and the phloëm. Often there are two or three cells that have no distinctive features of either cambium or phloëm. In order to establish a limit the phloëm was considered as starting with the first cell, in which the cells were markedly larger and more rounding, with walls less

¹ This discussion is based on work by Robt. P. Armstrong, graduate assistant, to whom the credit for it is due.

deeply stained. In this way a fairly satisfactory criterion was established. (See Plates III and IV.) Four to thirteen twigs of each variety were examined and five to ten measurements and counts of cambium cells made on each twig. No differences were detected between shoots from nursery trees and from bearing trees. Table 12 gives the results of these measurements.

TABLE 12. — *Thickness of the Bark and Cambium.*

	Per Cent rooting.	Thickness of Bark in Millimeters.	Thickness of Cambium in Microns.	Number of Cambium Cells.	Range of Number of Cambium Cells.
Bough (Sweet), ...	98	.513	80.0	10	9-11
Primate, ...	92	.628	86.1	10	9-10
Red Astrachan, ...	67	.633	80.5	10	9-13
Tompkins King, ...	62	.613	80.9	-	-
McIntosh, ...	74	.525	78.0	9	9-10
Northern Spy, ...	58	.665	75.0	8	8-10
Baldwin, ...	32	.611	56.0	6	8-9
Yellow Transparent, ...	26	.571	69.8	9	-9
Oldenburg, ...	25	.743	75.0	9	8-9
Jewett, ...	20	.689	67.2	9	-9
Tolman, ...	3	.592	58.0	7	7-8

It appears from this table that there is a difference in the thickness and number of cells in the cambium layer of the varieties examined, and that this is correlated with the ability of the variety to form roots from the scion. The only marked exception shown in the table is the Baldwin, which, having the fewest cells and the thinnest cambium layer of all, roots more freely than four of the other varieties studied. Further study of this question, including other varieties and extending through the growing season, should prove definitely whether we have here a significant reason for the variation in root formation among different varieties.

DISCUSSION OF THE RESULTS.

As a major result of the work here reported two facts are brought out: (1) varieties differ greatly in their readiness to form roots from the scion when propagated by the nurse-root method; (2) there is also great variation within the variety in the number that form roots from the scion.

Taking up first the varietal differences we find that a few varieties root in all, or nearly all, cases, while only one variety of *Pyrus malus* — Bethel — has failed entirely to yield trees rooted from the scion. Inasmuch as this variety was grown in rather small numbers and under con-

ditions where other varieties gave low percentages of rooting trees, it is probable that Bethel would, under more favorable conditions, give at least a low percentage of rooted trees. Considering the number of varieties tested it seems safe to say that any variety of the common apple may be propagated on its own roots by the nurse-root method.

There are fourteen varieties that have been propagated in considerable numbers in successive years and under different conditions, so that we may feel fairly certain that the percentage rooting is fairly representative for these varieties under the general conditions in which they have been grown. Arranged in order of percentage rooting they are as follows:—

Bough (Sweet), ...	98	Rhode Island Greening, ...	30
Red Astrachan, ...	67	Oldenburg, ...	26
Northern Spy, ...	58	Yellow Transparent, ...	26
Ben Davis, ...	51	Wealthy, ...	25
Wagener, ...	45	Hubbardston, ...	21
Transcendent, ...	45	Jewett, ...	20
Baldwin, ...	32	Tolman, ...	3

Coming now to the question of why certain of these varieties root better than others we find a rather difficult problem. We have made few investigations aimed directly at this question, but some discussions may be ventured.

The property of rooting is not directly correlated with vigor. Tolman is fully as strong growing a variety in the nursery as Bough. Furthermore, observations made on digging the trees fail to discover any noticeable correlation between vigor and rooting. It has seemed to the writer that a small, weak tree was as likely to be rooted from the scion as a strong one.

Some varieties branch more freely than others. During the season of 1916 a block of yearling whips branched quite freely from the newly formed axillary buds. Notes taken at the time are as follows: No branches, Northern Spy; few, Baldwin, Bough, Oldenburg, Tolman; all, Transcendent (Crab). This gives no indication of any correlation between rooting from the scion and branch growth from axillary buds. A more reasonable expectation might be for a correlation between root formation and branching from adventitious buds on the stem. No exact record of branching from adventitious buds is available, but limited general observation of the behavior of budded trees leads the writer to believe that such a correlation may exist, and that Bough and other free rooting varieties do send out shoots from adventitious buds more freely than Tolman and other varieties that root only sparingly. Further and more definite records may prove or disprove this belief.

The relation of callus formation in cuttings has been referred to. (See page 75, Fig. 1.) Unfortunately no full notes of callus formation on the cuttings set was kept, but it is suggestive to point out that Yellow

Transparent, which uniformly gave as large a callus as any variety, did not root as well as Wagener, which never gave any sign of callus formation.

Neither can we discover any relationship between rooting from the scion and season of maturity, either of fruit or wood, nor in size of leaves or density of foliage.

Many woody plants are propagated from cuttings, and in general it is those with soft wood that grow most readily. There is considerable variation in hardness of wood among different varieties of apples, and we may inquire if those with softer wood are the ones that root most readily from the scion. No extended investigation of this question has been made at this station. Beach and Allen¹ made extensive tests of the hardness of wood of different varieties. They found considerable difference within the variety, and a clear comparison of their results with rooting ability, as shown by their investigation, is difficult, but a general survey of their results leads to a belief that there is a general correlation. It is, however, subject to exceptions. Beach and Allen came to the conclusion that there was a correlation between hardness of wood and resistance to winter cold, and here again there seems to be a rather loose correlation with rooting ability. Oldenburg and Wealthy are very hardy and root poorly, and Bough is tender and roots well. But Ben Davis is quite hardy and roots comparatively well, and Hubbardston and Tolman are less hardy than Wealthy and do not root so well.

Wide variations in the rooting ability of different lots of the same variety are evident. Some of these are clearly seasonal. Such differences may be due to climatic conditions, to soil conditions, — for the soils used in different years are not all alike, — or they may be due to difference in the scions used. Any such difference would most likely trace back to the growing conditions the previous season as affecting stored food and possibly structure. Slight differences in cultural treatment may have had an effect. Varying rainfall may have had an influence. It is impossible from the evidence at hand to determine which of these possible factors have had an influence and to what extent.

The general low percentages of Series 6 (Table 5) are striking, and the writer feels that they are due largely to poorly drained soil which prevailed over a considerable portion of the plot. While no direct comparisons are possible, careful observation indicated that rooting was better on the drier portions of the plot. A part of the plot on which Series 4 was grown was poorly drained, and may account for the rather low average of this series.

¹ Ia. Expt. Station Res. Bul. 21 (1915).

SUMMARY.

1. Stem cuttings of the common apple grow only rarely; in the trials here reported none succeeded, though callus formation in some varieties was good.
2. Root cuttings grew well, especially when young roots were used, though growth was slow the first season.
3. Limited tests indicated that most varieties may be readily propagated by mound layers.
4. The best means of establishing trees on known roots is by the nurse-root method. The scion is whip-grafted on a short piece of root and planted deeply; at the end of one or two seasons' growth the tree is dug, the seedling root removed and the tree replanted. Neither dwarf apple nor pear roots are of value as nurse roots.
5. Varieties vary greatly in the readiness with which they send out roots from the scion, the proportion varying from none to practically all with different varieties.
6. There is also great variation within the variety in the numbers rooting from the scion.
7. Varietal differences may be loosely correlated with density of the wood, the softer the wood the higher the proportion rooting from the scion.
8. A fertile, well-drained, sandy loam probably offers the best conditions for securing a high percentage of rooting trees.
9. Once trees are established on known roots they may be propagated by root cuttings or by root grafting on known roots.
10. There seems to be a relation between the varietal ability to produce roots from the scion and the thickness of the cambium layer at the dormant season.

PLATE I.



FIG. 1. — Green wood apple cuttings, showing callus formation. From left to right, Yellow Transparent, Fall Pippin, Red Astrachan, Bough, Ben Davis, Wagener.



FIG. 2. — Matching cambium in root grafts: (a) one side only; (b) both sides only; (c) top only; (d) bottom only; (e) perfectly matched.

PLATE II.



FIG. 3. — Trees rooted from the scion after cutting off seedling nurse root; two-year-old trees cut back in spring of second year. Tolman at left, Bough at right, showing stronger roots of the latter.



FIG. 4. — Own-rooted Red Astrachan two years after cutting off seedling root.

PLATE III.

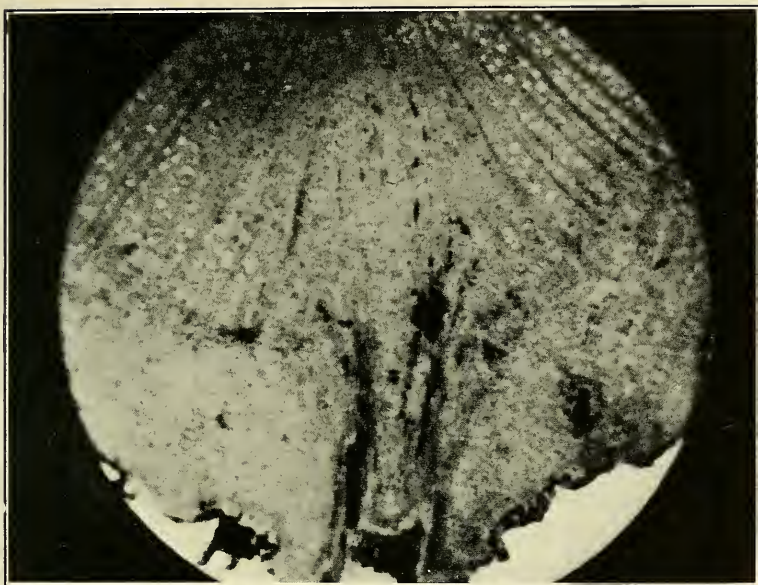
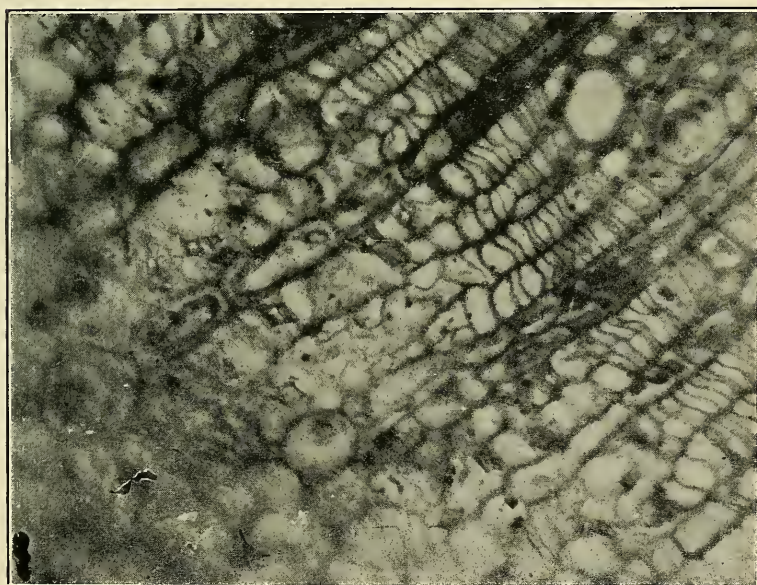


FIG. 5. — Section of Bough scion, showing origin of a young root.



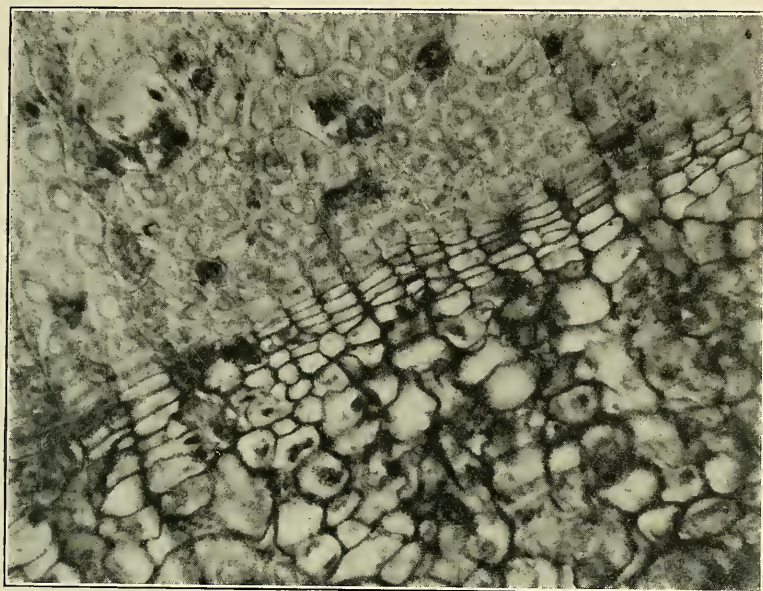
Xylem.

Cambium.

Phloem.

FIG. 6. — Section of Bough, showing xylem, cambium and phloem. The cambium layer has nine or ten cells.

PLATE IV.

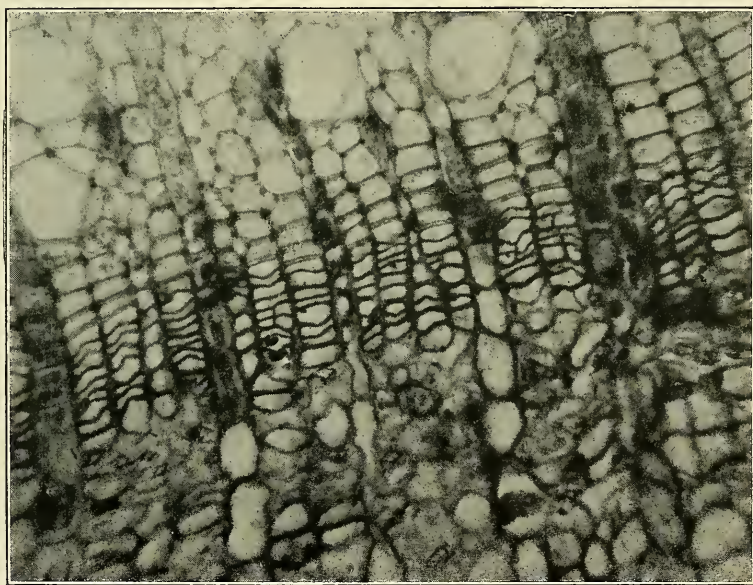


Xylem.

Cambium.

Phloëm.

FIG. 7. — Section of Baldwin, showing the thin cambium layer, averaging about five cells.



Xylem.

Cambium.

Phloëm.

FIG. 8. — Section of Tolman, showing cambium layer, averaging about eight cells.

BULLETIN No. 191.

DEPARTMENT OF POULTRY HUSBANDRY.

PRACTICAL RESULTS FROM STUDIES ON EGG PRODUCTION.

H. D. GOODALE.

INTRODUCTION.

A series of short papers, dealing with phases of egg production from the purely practical standpoint, has been planned. They will be published from time to time as circumstances admit. Their aim is to present as definite information on the subject of each as the evidence warrants. The detailed data on which these practical papers are based are in process of being published elsewhere. Those already published are —

Internal Factors Influencing Egg Production in the Rhode Island Red Breed of Domestic Fowl. *American Naturalist*, Vol. LII, No. 614, 1918, 3 parts, pp. 65-94, 209-232, 301-321.

Winter Cycle of Egg Production in the Rhode Island Red Breed of Domestic Fowl. *Journal of Agricultural Research*, Vol. XII, No. 9, 1918, pp. 547-574.

The Bearing of Ratios on Theories of the Inheritance of Winter Egg Production. *Journal of Experimental Zoölogy*, Vol. 28, No. 1, 1919, pp. 83-124.

I. INBREEDING.

The poultryman often is in a quandary regarding inbreeding. On the one hand it is advocated, and on the other just as strongly condemned. What, then, are the facts?

Inbreeding may be defined as the mating of relatives, and just as there are degrees of relationship so there are degrees of inbreeding. Line breeding involves inbreeding, so designed, however, as to keep its amount at a minimum.

In the work at this station close matings of various sorts have been made as well as unrelated matings. The results afford a *practical* answer to the question, shall I inbreed? The answer is found in a paraphrase of an old saying, which is applicable to all breeding, "Handsome is that handsome breeds," that is, inbreeding is to be judged by its results. This is a special application of the well-known progeny test. Now experience shows

that the results of some inbred matings are very good, while others are poor. But, contrariwise, sometimes the results of matings between unrelated birds are poor, while others are good. Nevertheless, matings between unrelated birds are almost universally approved, while inbreeding is often condemned.

In this bulletin no attempt will be made to answer most of the questions that arise concerning inbreeding, but evidence that inbreeding may be highly advantageous will be presented.

The Evidence.

1. Male No. 8097 produced 10 daughters, by his sister, that averaged 155.7 eggs each. The father of this pair also came from a brother-sister mating. On the other hand, male No. 8097 by a half first cousin produced 14 pullets that averaged 156.7 eggs each. There is no relation here between the degree of kinship (or inbreeding) and egg production.

2. The offspring of male No. 8147 by 4 females furnish interesting comparisons, as shown in the table, and are selected because the whole situation appears here in a nutshell. Eleven daughters by female No. 9420, which laid 221 eggs, averaged 190.1 eggs each. Female No. 9420 is distantly related to male No. 8147 five generations back through a single bird. By female No. 8652, laying 196 eggs, with a much inbred and tangled line of descent and closely related to himself (see figure), there were 9 daughters, with an average of 181.5 eggs. Moreover, the highest producing individual in the two families, viz., B2088, with a record of 237 eggs, was a daughter of female No. 8652. On the other hand, female No. 8418, laying 139 eggs, also closely related to male No. 8147 (see figure), produced 11 pullets sired by him that averaged only 156 eggs each. Finally, there is the mating of female No. 8185 with male No. 8147. This female is related to male No. 8147 in exactly the same degree as female No. 9420 (though otherwise unrelated to No. 9420) and through the same great, great grandparent. Unfortunately her 11 daughters were not all trapped through the year, as they would have been if there had been any inkling of their importance. We are obliged to fall back on their winter records. Their average for the winter was 42.9 eggs each (which gives an estimated annual average of 142.9 eggs), while the daughters of female No. 9420 averaged 75.3 each; those of female No. 8652 averaged 62.4 each, and of female No. 8418, 50.5 each. These averages refer to the number of eggs laid before March 1 of the pullet year. Female No. 8185 was a good winter layer herself with a record of 85 eggs and a 365-day record of 185 eggs, but came from a mediocre family.

*Details relating to the Egg Records of the Progeny of one Male.**Father No. 8147.*

NUMBER.	Date hatched.	Age at First Egg (Days).	Date of First Egg.	Eggs to March 1.	Annual Production.	Remarks.
<i>Mother.</i>	1916.					
8185, . . .	Apr. 16	195	Oct. 28	85	186	
<i>Daughters.</i>	1917.					
B 830, . . .	Apr. 8	229	Nov. 23	77	-	Did not complete year.
B1147, . . .	Apr. 15	261	Jan. 1	29	-	Did not complete year.
B 1150, . . .	Apr. 15	208	Nov. 9	61	-	Did not complete year.
B 1372, . . .	Apr. 22	213	Nov. 21	48	-	Did not complete year.
B 1541, . . .	Apr. 29	217	Dec. 2	64	142	
B 1990, . . .	May 6	253	Jan. 14	35	-	Did not complete year.
B 2206, . . .	May 13	213	Dec. 12	9	-	Did not complete year.
B 2208, . . .	May 13	212	Dec. 11	38	-	Did not complete year.
B 2209, . . .	May 13	198	Nov. 27	29	114	
B 2210, . . .	May 13	229	Dec. 28	39	-	Did not complete year.
Average, . .	Apr. 30	233.3	Dec. 9	42.9	142.9 ¹	
<i>Mother.</i>	1916.					
9420, . . .	May 28	169	Nov. 13	75	221	
<i>Daughters.</i>	1917.					
B 83, . . .	Mar. 18	227	Oct. 31	106	223	
B 242, . . .	Mar. 25	182	Sept. 23	120	202	
B 243, . . .	Mar. 25	197	Oct. 8	77	198	
B 244, . . .	Mar. 25	180	Sept. 21	67	137	
B 557, . . .	Apr. 1	224	Nov. 11	66	213	
B 558, . . .	Apr. 1	208	Oct. 26	53	171	
B 845, . . .	Apr. 8	168	Sept. 23	93	207	
B 1125, . . .	Apr. 15	202	Nov. 3	80	199	
B 1126, . . .	Apr. 15	182	Oct. 14	81	181	
B 1127, . . .	Apr. 15	178	Oct. 10	86	174	
B 1679, . . .	Apr. 29	247	Jan. 2	29	-	Failed to complete year.
B 1986, . . .	May 6	201	Nov. 23	55	-	Failed to complete year.
B 2065, . . .	May 13	191	Nov. 20	66	186	
Average, . .	Apr. 10	199	Oct. 26	75.3	190.1	

¹ Estimated.

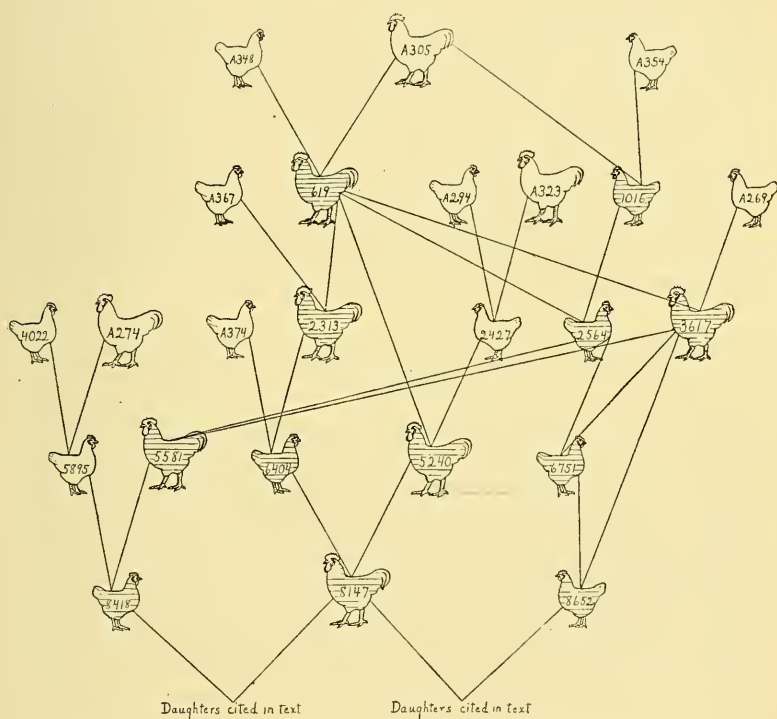
*Details relating to the Egg Records of the Progeny of one Male—Con.**Father No. 8147—Con.*

NUMBER.	Date hatched.	Age at First Egg (Days).	Date of First Egg.	Eggs to March 1.	Annual Production.	Remarks.
<i>Mother.</i> 1916.						
8418, . . .	Apr. 23	213	Nov. 22	76	139	
<i>Daughters.</i> 1917.						
B 168, . . .	Mar. 18	201	Oct. 5	88	—	Failed to complete year.
B 172, . . .	Mar. 18	234	Nov. 7	48	162	
B 252, . . .	Mar. 25	195	Oct. 6	57	132	
B 254, . . .	Mar. 25	241	Nov. 21	59	176	
B 255, . . .	Mar. 25	229	Nov. 9	53	136	
B 454, . . .	Apr. 1	205	Oct. 23	74	209	
B 876, . . .	Apr. 15	244	Dec. 15	28	138	
B 877, . . .	Apr. 15	203	Nov. 4	80	181	
B 879, . . .	Apr. 15	214	Nov. 15	32	84	
B 1290, . . .	Apr. 22	224	Dec. 2	61	165	
B 1832, . . .	May 6	235	Jan. 3	21	147	Failed to complete year.
B 1835, . . .	May 6	226	Dec. 18	51	—	
B 2172, . . .	May 13	218	Dec. 17	49	173	
B 2173, ¹ . . .	May 13	197	Nov. 26	8	78	Nester.
B 2174, . . .	May 13	218	Dec. 17	48	169	
Average, . . .	Apr. 13	220.5	Nov. 20	53.5	156.0	
<i>Mother.</i> 1916.						
8652, . . .	Apr. 30	204	Nov. 20	78	196	
<i>Daughters.</i> 1917.						
B 156, . . .	Mar. 18	189	Sept. 23	73	198	Failed to complete year.
B 192, . . .	Mar. 25	181	Sept. 22	89	—	
B 194, . . .	Mar. 25	180	Sept. 21	62	154	
B 722, . . .	Apr. 8	197	Oct. 22	65	169	
B 988, . . .	Apr. 15	219	Nov. 20	31	123	
B 1361, . . .	Apr. 22	192	Oct. 31	82	205	
B 1362, . . .	Apr. 22	225	Dec. 3	67	215	
B 1646, . . .	Apr. 29	216	Dec. 1	52	194	
B 1824, . . .	May 6	213	Dec. 5	55	139	
B 2083, . . .	May 13	225	Dec. 24	48	237	
Average, . . .	Apr. 15	203.7	Nov. 5	62.4	181.5	

¹ Not included in averages.

It may be of interest to note that the difference in average winter production of these groups of half sisters is closely related to average date of first egg. Thus, the average date of first egg of the daughters of female No. 9420 was October 26; of female No. 8652, November 5; of female No. 8418, November 17; and of female No. 8185, December 12.

Thus, of 4 females mated with a single male, 2 were inbred and 2 were unrelated to the male. The offspring of one inbred female were good layers, while those of the other were relatively poor. The offspring of one unrelated female were good layers, and of the other relatively poor. The results of inbreeding, therefore, must be judged by the quality of the offspring. If it is good, utilize those particular inbred matings. If not good, try other inbred matings.



DESCRIPTION OF FIGURE. — The line of descent of two inbred families. A pair of divergent lines extend from the *back* of each bird whose pedigree is known, one going to the father, the other to the mother, and ending on the under side. From this figure the various inter-relationships may be made out. Thus 8147's sire is 5240 and his dam 6404. The sire of 5240 is 619, who is also the grandsire of 6404 as well as the sire of 2564 and 3617; 619 is therefore the great, great grandsire of the daughters of 8147, through some lines of descent, but only the great grandsire through others. No. 3617 is equally a half great, great uncle, grandsire and great grandsire of 8652's daughters. The birds with backs free of lines are foundation stock of unknown ancestry. The inbred lines of descent are indicated by the shaded birds.

3. A few instances may be added to show that the results of matings between unrelated birds may be very inferior to matings between closely related birds such as those just described, unless special attention is paid to egg production. Thus, female No. 6982 had 10 daughters, by an unrelated male, that averaged 101 eggs each, exactly their mother's record. The same male by female No. 5832, also unrelated, and laying 160 eggs, produced 7 daughters that averaged 151.7 eggs each. Another male, by an unrelated hen that laid 234 eggs, had 9 daughters that averaged 139.1 eggs each.

In these experiments good, strong, healthy stock has been used. The families from which the males were to be chosen were selected on the basis of their sisters' performance, and the strongest, most virile male in each family selected for breeding.

There is one thing more to be said on the subject. In our experience the very best results have come from outmatings, while the very poorest have come from close matings. *It is clear, then, that very great care must be used when inbreeding, lest disaster overtake the breeder unawares.* Very careful and accurate pedigrees and other records must be kept. Further, the provisional conclusion appears justified that the very best results are most likely to be obtained by crossing two distinct lines, each of which is inbred and which is doing well. Very likely the best way to renew the commercial egg flock is through the crossing of strong, high-producing, inbred lines, which will, of course, be maintained intact by inbreeding, and making the cross anew each season.

II. IS THE INFLUENCE OF THE MALE OR OF THE FEMALE THE MORE IMPORTANT?

The view that high fecundity does not descend from mother to daughter but does descend from mother to son, or from father to both sons and daughters is now generally accepted. This, then, leads to the belief that the use of the sons of high layers insures high production in the progeny sired by such sons. The male is regarded as all important, the female of importance only as a producer of good males. This situation has arisen apparently from the attempt to describe certain modes of inheritance in every-day language. The scientific foundation, *i.e.*, sex-linked inheritance of fecundity, on which the view mentioned is based does not warrant the popular interpretation which it has received. However this may be, evidence is now available which indicates that high fecundity is not sex-linked in some breeds, at any rate.

In speaking of fecundity the use of the terms high and low are not very precise for they are relative; we may, however, use them with this understanding of their limitation. In this bulletin winter production only is considered, because it is a fairly good index of a hen's inborn capacity to lay.

The important question to be answered is: Is it possible for high-egg production to descend from mother to daughter? An experiment was made

in which a male from a low line was mated with several high producers belonging to a high line and at the same time to several low producers. Of course careful individual pedigrees were kept. The offspring of the high producers averaged 49.2 winter eggs against an average of the mothers and their sisters of 52.5 eggs. Nearly all were high producers. On the other hand, the offspring of the poor layers averaged only 11.6 winter eggs. In this experiment high production clearly descended from mothers to daughters.

In another experiment a male was used that came from a high-producing mother, but on the father's side production was poor. Some of his mates were good producers, some were poor. A few daughters were good layers, but most of them, regardless of whether their mother was a high or low producer, were mediocre to poor. In this experiment the influence of the male was more pronounced.

In other experiments males derived from high lines have been bred to low producers. For example, male B137, a high-line male, was bred to two low birds of low lines. The average winter production of the daughters was high, viz., 54.5 eggs. On the other hand, in the table of the section on inbreeding is shown a case where the production of the offspring of a male belonging to a high line, bred to a high-producing female, viz., No. 8185, of a mediocre line, was relatively poor compared with that obtained from the offspring of females belonging to high lines.

In still another experiment a male belonging to a low line was mated with a female belonging to another low line. Most of the offspring were *high* producers.

These experiments show that we are dealing with a situation that is complicated in many ways. It appears, however, to be perfectly clear that both male and female play a part in determining the egg production of their daughters. Whether one is more important than the other depends upon the particular individuals that are mated. In breeding for high production the influence of either must be judged by the production of the offspring. The aim of the breeder should be to produce a line that will give high average production and that will reproduce itself generation after generation. To this end the contribution of both father and mother must be made. Any male or any female, or a particular combination of a certain male with one or more females that give high production consistently, may well be used as breeders as long as they live, or till something better has been secured.

III. THE EXCLUSION OF PARASITES.

The investigations on the inheritance of fecundity have led in several unexpected directions. If an analysis of the hereditary basis of fecundity is to be made, it is evident that the problem must be reduced to its simplest form. Disturbances introduced by the surroundings must be avoided. For example, the date at which a pullet lays her first egg influences her

record. This date is determined in part by the date she was hatched and in part by the age at which she matures, and this in turn is influenced by various growth factors, some hereditary, some environmental. Of the latter, parasites, visible or invisible to the naked eye, especially those that are concerned in causing disease, must be under control. It is a biological law that just as a chicken or a dog requires parents so all life arises from pre-existing life. As far as is known with certainty, with the exception of the parasite that causes bacillary white diarrhoea, the chick enters the world free from parasites. If, therefore, a means can be found to keep such parasites away, the chick will never have them, and will not suffer from them. The means is found in a quarantine of the chicks, and in an extension of the rotation method introduced by the Maine Agricultural Experiment Station.

A suitable quarantine, which presupposes the use of artificial methods of hatching and rearing, is a very efficient method of keeping out parasites and disease resulting therefrom, and in many circumstances is the simplest and least laborious method of securing the desired end. In the work at the Massachusetts Agricultural Experiment Station a plot of ground was selected that had not had a chicken or chicken manure on it for several years. All buildings, appliances and utensils were either new or were scrubbed clean enough to eat from. Then everything not new was drenched outside and inside with 5 per cent coal tar disinfectant. One spraying was made before the buildings were moved, another after their removal to the clean ground. The chicks were hatched in carefully disinfected incubators. A separate attendant did the brooding and was quarantined from all other poultry. At the entrance to the rearing ground he changed his foot gear for a set reserved for use on the rearing ground, and, after changing, walked through a pan of strong disinfectant. Every loop-hole by which parasites might gain entrance was closed if at all possible. The result is that the parasite problem has been largely solved as long as the chicks remain quarantined.

The quarantine method of rearing chicks should be of particular advantage to any one who is starting a new poultry plant, because by purchasing eggs of stock free from bacillary white diarrhoea, and using only artificial methods for hatching and rearing, the proverbial good luck of the beginner should endure.

BULLETIN No. 192.

DEPARTMENT OF AGRICULTURE.

REPORT OF THE CRANBERRY SUBSTATION FROM 1917 TO 1919.

BY H. J. FRANKLIN.

The 1915 and 1916 lines of work were followed closely in 1917, but a collection of cranberry bog weeds was started and a long and searching study was made of the weather records, bearing on frost conditions, taken at the station from 1913 to 1917, inclusive. Storage tests with the fruit were continued as an important part of the work, with interesting results.

The 1918 work followed the general plan of other years. Special attention was given to frost predicting, the methods being much perfected. The storage tests were largely suspended, as the handling of the unusually large station crop left little room in the screenhouse for them. About 60 species of cranberry bog weeds were collected by the writer and identified, with the help of Prof. A. V. Osmun of the Massachusetts Agricultural College, and Dr. H. F. Bergman of the Bureau of Plant Industry. By agreement between the Massachusetts Agricultural Experiment Station and the Cape Cod Cranberry Growers' Association, the writer gave much time to developing a cranberry harvester, fair progress apparently being made. With the help of a special appropriation of the Legislature the iron roof of the screenhouse was replaced with boards and shingles, and the roof frame strengthened.

FUNGOUS DISEASES.

The co-operative investigation of diseases and of handling, storing and shipping the fruit was conducted in 1917 much as in 1916, Dr. C. L. Shear of the Bureau of Plant Industry and his assistant, Mr. B. A. Rudolph, making the more technical studies, and Dr. N. E. Stevens giving valuable aid in the planning and performing of practical experiments carried out in the cranberry section where he spent most of the fall months, a large part of his work being done at the station.

Copper sulfate put in the June flowage as a means of controlling diseases was tried in 1917 as in previous years, but without positive results.

Tables 1 and 2 show the results of spraying with "Corona" arsenate of lead. In the 1917 treatments this insecticide was used at the rate of 4 pounds to 50 gallons of water, with 2 pounds of Good's caustic potash fish-oil soap No. 3 added. The plots were sprayed three times, — June 26 and 27, July 25 and 26 and July 30. The third application followed the second so closely because a severe storm washed the latter severely soon after it was made. In 1918 the plots were sprayed four times, — June 11, June 27, July 19 and 20 and August 3. In the first two applications 3 pounds of the arsenate to 50 gallons of water were used, and the last two treatments were the same except that soap was added as in 1917. The 1918 plots A. L. 1 to A. L. 4, inclusive, were the same areas, respectively, so numbered in 1917. In both years the checks were laid out on different sides of and adjacent to the plot in each case. All the plots and checks were of the Early Black variety. The berries were all picked with scoops. The fruit was stored in bushel picking crates as it came from the bog, and was placed in storage the day it was picked. The quantity stored in 1917 varied from 1 to 6 bushels for the different plots and checks, while in 1918, 8 bushels from each plot and check were used.

The crates were examined by the "seven-sample" method to determine the percentages of berries showing decay. In this method seven samples from each crate are examined, one being taken from the surface berries of each half of the crate halfway between the middle and end; one from each half of the crate halfway between the top and bottom and halfway between the center and end; one from the very center; and one from the very bottom of each half of the crate halfway between the middle and end. This seems a most satisfactory way to sample in inspecting the crated fruit.

Both years all the plots but A. L. 2 yielded fruit of much better quality than that from the check areas, the improvement being most marked in 1918, when more treatments were applied. These tests and those of 1916¹ show that arsenate of lead has a distinct fungicidal value as a treatment for the Early Black variety. What fungi are affected by it, however, has not been determined.

¹ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, pp. 189-192.

TABLE 1. — *Spraying Plots (Fungous Diseases) treated with Arsenate of Lead, 1917.*

PLOTS AND CHECKS.	Area (Square Rods).	Yield per Square Rod (Bushels).	Period of Storage.	Per- centage of Berries showing Decay at End of Storage.
A. L. 1, ...	9	.35	Sept. 14 to Dec. 19	48.54
A. L. 1 (check 1), ...	9	.22	Sept. 14 to Dec. 19	62.27
A. L. 1 (check 2), ...	6	.31	Sept. 14 to Dec. 19	56.07
A. L. 2, ...	9	.61	Sept. 14 to Dec. 20	65.26
A. L. 2 (check 1), ...	9	.28	Sept. 14 to Dec. 19	78.89
A. L. 2 (check 2), ...	6	.45	Sept. 14 to Dec. 20	62.81
A. L. 2 (check 3), ...	6	.61	Sept. 14 to Dec. 20	53.68
A. L. 3, ...	9	1.15	Sept. 20 to Dec. 18	37.33
A. L. 3 (check 1), ...	9	1.15	Sept. 20 to Dec. 18	49.58
A. L. 3 (check 2), ...	4½	.86	Sept. 20 to Dec. 17	47.42
A. L. 3 (check 3), ...	9	1.02	Sept. 20 to Dec. 17	45.39
A. L. 4, ...	8	1.08	Sept. 20 to Dec. 18	35.84
A. L. 4 (check 1), ...	8	.81	Sept. 20 to Dec. 19	41.81
A. L. 4 (check 2), ...	6	1.13	Sept. 20 to Dec. 18	49.08

TABLE 2. — *Spraying Plots (Fungous Diseases) treated with Arsenate of Lead, 1918.*

PLOTS AND CHECKS.	Area (Square Rods).	Yield per Square Rod (Bushels).	Period of Storage.	Per- centage of Berries showing Decay at End of Storage.
A. L. 1, ...	9	1.48	Sept. 25 to Jan. 2	56.09
A. L. 1 (check 1), ...	6	1.39	Sept. 25 to Jan. 2	62.23
A. L. 1 (check 2), ...	6	1.61	Sept. 25 to Jan. 2	75.62
A. L. 1 (check 3), ...	6	2.13	Sept. 25 to Jan. 2	69.05
A. L. 2, ...	9	1.91	Sept. 25 to Jan. 6	64.43
A. L. 2 (check 1), ...	6	2.00	Sept. 25 to Jan. 2	82.58
A. L. 2 (check 2), ...	6	1.80	Sept. 25 to Jan. 6	64.71
A. L. 2 (check 3), ...	6	2.61	Sept. 25 to Jan. 7	58.67
A. L. 3, ...	9	2.14	Sept. 11 to Dec. 27	12.07
A. L. 3 (check 1), ...	6	2.45	Sept. 11 to Dec. 27	42.04
A. L. 3 (check 2), ...	6	2.33	Sept. 11 to Dec. 27	35.99
A. L. 4, ...	8	2.18	Sept. 11 to Dec. 27	13.01
A. L. 4 (check 1), ...	8	2.59	Sept. 11 to Dec. 27	39.94
A. L. 4 (check 2), ...	8	2.53	Sept. 11 to Dec. 26	39.25
A. L. 5, ...	9	2.15	Sept. 17 to Dec. 26	17.60
A. L. 5 (check 1), ...	6	2.00	Sept. 17 to Dec. 26	26.50
A. L. 5 (check 2), ...	6	1.89	Sept. 17 to Dec. 26	30.18
A. L. 5 (check 3), ...	6	2.11	Sept. 17 to Dec. 26	32.71
A. L. 6, ...	8	1.81	Sept. 16 to Dec. 30	20.43
A. L. 6 (check 1), ...	8	2.06	Sept. 16 to Dec. 30	39.83
A. L. 6 (check 2), ...	8	2.08	Sept. 16 to Dec. 30	36.60
A. L. 7, ...	8	2.25	Sept. 22 to Dec. 30	17.84
A. L. 7 (check 1), ...	8	2.25	Sept. 22 to Dec. 30	42.18
A. L. 7 (check 2), ...	4	2.25	Sept. 22 to Dec. 30	41.79
A. L. 7 (check 3), ...	8	2.38	Sept. 22 to Dec. 30	47.64

Tests were made in both 1917 and 1918 to determine the effect of Black-Leaf 40 on cranberry diseases. This was used at the rate of 1 part to 400 parts of water, and 2 pounds of resin fish-oil soap to 50 gallons were added. The fruit was picked, stored and examined in the same way as that from the arsenate of lead plots. No positive effect of this treatment on the quality of the fruit was shown by the experiments.

The "rose bloom" disease caused by *Exobasidium oxycocci* Rostr. was prevalent, and deformed many of the blossoms on several bogs in both 1917 and 1918, doing more harm than in any year since 1907, and greatly reducing the crop wherever abundant. It affected late varieties mostly, harming Early Black vines on only a few bogs. In 1917 nearly all the new shoots on large portions of the Howes sections of the station bog showed the abnormal enlargement caused by the disease. These growths were first seen the latter part of May, and were present in full development and abundance until the bog was flowed for worms the night of June 22. When the bog was examined again at 6 P.M. on June 25 (after the water was let off), all the "rose blooms" had turned black and shriveled so much they could hardly be found. The forty-six-hour flooding and the subsequent drying of the vines by strong sunlight had killed the diseased shoots on all parts of the bog.

The station bog was flowed from Sept. 29 to Oct. 13, 1917, and was flowed for the winter on December 13. The winter water was let off April 4, 1918. In 1918 the "rose bloom" growths were somewhat less abundant on this bog than in 1917, but the disease destroyed most of the crop on two sections. The 1918 growing season was quite dry, but the disease deformed many blossoms.

In 1918 spraying tests with Scalecide and resin fish-oil soap to kill the "rose bloom" shoots were tried, as follows:—

1. One gallon to 25 of water with one-half pound of soap applied May 29. This killed most of the "rose bloom" shoots, but left a considerable percentage. It destroyed most of the prospective cranberry bloom, but did not kill the tips of the growing uprights.

2. One gallon to 37½ of water with three-fourths pound of soap applied May 29. This failed to kill a large percentage of the diseased shoots. It destroyed most of the prospective cranberry bloom, but did not kill the tips of the growing uprights.

3. One gallon to 50 of water with 1 pound of soap applied May 29. This failed to kill a large proportion of the diseased shoots. It destroyed most of the prospective bloom.

4. One gallon to 100 of water with 2 pounds of soap applied May 29. This affected the buds and diseased shoots but little.

On the whole, these tests were of little value.

Spraying with iron sulfate to kill the diseased growths was also tried in 1918, as follows:—

1. Three pounds in 12 gallons of water applied June 1. This killed the diseased shoots fairly well and injured the cranberry uprights but little.

2. Five pounds in 10 gallons of water applied June 1. This killed all the diseased shoots and hurt the uprights little.

3. Five pounds in 10 gallons of water applied May 31. This killed all the diseased shoots and reduced the prospective crop more than 50 per cent.

4. Ten pounds in 10 gallons of water applied May 29. This killed all the "rose bloom" shoots and hurt the uprights but little.

5. Twenty pounds in 10 gallons of water applied May 29. This killed all the diseased shoots and injured the uprights severely.

These experiments suggest that the sulfate may be used to combat the disease successfully if applied at a right strength often enough to prevent the infected shoots from developing to the condition in which they give off spores. To be thorough enough this treatment might necessitate the sacrifice of the crop of the season in which it was used, and also, by destroying the bud-bearing tips of the new growth, that of the next year. As fresh spores were found on the diseased growths on May 20, 1918, the spraying, if tried, should be begun fairly early in the season.

The station bog was completely flooded June 3, 1918, and the water was held forty-four hours. The "rose bloom" shoots turned dark and shriveled soon after the water was let off, just as they did after the 1917 flooding. It seems from this that such submergence can be relied on to destroy these growths.

The diseased shoots were well developed and plentiful on the station bog on May 18, 1918, but they did not seem to be giving off spores then. The winter buds in the tips of the cranberry uprights were enlarged but not opened at all at the time, and therefore probably were not in condition to receive a new infection from the spores of the disease. The infected axillary buds apparently develop earlier than the healthy terminal buds.

These observations and the effect of the June floodings on the "rose bloom" growths suggest that where water supplies are adequate the disease may be controlled by letting off the winter water about May 20 and flooding again for from two to three days when the terminal buds are developed to the point of breaking open. This treatment would allow the diseased, spore-producing shoots to grow, but would destroy them before the new cranberry growth developed enough to become susceptible to infection.

The writer has never yet found "rose bloom" very prevalent on a bog that was regularly reflowed after picking.

Table 3 compares the experience had with Early Black and with Howes cranberries which were left unpicked and subjected to the long (September 29 to October 13) after-picking flooding in 1917 with that had with berries of the same varieties picked before the flowing from vines near those bearing the submerged fruit. The Early Black berries decayed remarkably in the water, the main fungus causing the rot, as determined by Dr. Shear, being *Sporonema oxycocci* Shear. The Howes fruit picked after the flooding, however, showed less decay than that gathered and stored before it, this probably being due to a considerable development of "end-

rot" (caused by *Fusicoccum putrefaciens* Shear) in the stored fruit. A few of the flooded berries of this variety showed small spots of rot caused by *Sporonema*, but no "end-rot."

It seemed impossible to get the flooded berries dry for picking after the water was let off, chiefly because the many shells left by fruit worms were full of water and would dry out but slowly; therefore the fruit finally was picked and stored wet.

The berries were stored in picking crates, two bushels being used in each lot. They were examined for rot when placed in storage, October 25, and again at the end of the storage period, December 27.

TABLE 3. — *Effect of a Long Fall Flooding on Ripe Early Black and Howes Berries.*

VARIETY.	Lot No.	Picked before or after Flooding.	Date picked.	Condition when picked and stored.	PERCENTAGE OF BERRIES SHOWING DECAY.	
					Before Storage.	At End of Storage.
Early Black, ...	1	Before	Sept. 27	Dry	13.50	40.26
	2	After	Oct. 17	Wet	63.35	88.08
Howes, ...	1	Before	Sept. 27	Dry	17.45	36.23
	2	After	Oct. 17	Wet	14.68	56.85

A like test made at the station in 1914 gave much the same results as this one, the flowage promoting rapid decay among Early Black berries, but not doing so among Howes.

The fact that the submerged Howes berries showed less rot than those picked before the flooding confirms the opinion given in a previous report,¹ that fruit of this variety should never be picked before the end of the first week in October. If left until then it not only will have better size and color, but also will include less rot when prepared for shipment. Late picking of Howes berries is especially desirable where this variety usually develops much "end-rot" (*Fusicoccum*) in storage.

Although unpicked ripe Howes berries evidently endure rather long submergence without appreciable deterioration, this is not advisable, especially if they have been much infested with fruit worms, because they are so hard to get dry afterward.

Table 3 confirms the comparative results of storing cranberries wet or dry shown elsewhere (page 122) in this report and in a former one.²

The McFarlin vines on the station bog usually bear sound berries. In both 1916 and 1917 this fruit was of exceptional quality for the variety in spite of the unusual wetness of those seasons, keeping nearly as well as the Howes berries. The season of 1918 was much drier than those of 1916 and 1917, but fully half the station McFarlin berries rotted on the

¹ Bul. No. 168, Mass. Agr. Expt. Sta., 1916, p. 19.

² Bul. No. 180, Mass. Agr. Expt. Sta., 1917, pp. 201-204.

vines, the fungus mainly responsible being found by Dr. Shear to be that of bitter-rot, *Glomerella cingulata vaccinii* Shear. The Howes berries on the same part of the bog also showed much more rot than usual when picked, and they looked as though they were affected by the same fungus, but this was not definitely determined. The bitter-rot had affected the Early Black variety on this bog considerably in previous years, but its sudden severe infection of the later varieties is remarkable.

The holding of winter flowage until midsummer, thus sacrificing one season's crop, is practiced often in New Jersey, and occasionally on the Cape, as a means of reducing pests.¹ The New Jersey growers who have had most experience with this treatment claim that the year after its application a large crop of berries of unusual size and excellent keeping quality is obtained. "The benefits, both in the reduction of field rot and in the improvement of keeping quality, are frequently said to persist for several years."² One grower of large experience told the writer he had failed to improve the keeping quality of Howes berries from New Jersey bogs so treated the year before by spraying with Bordeaux mixture.

Two valuable papers on cranberry diseases have been published recently, — one by Dr. C. L. Shear on "end-rot" (*Fusicoccum putrefaciens* Shear),³ and the other by Dr. N. E. Stevens on the relation of regional temperatures to the growth of cranberry fungi,⁴ both being quite technical.

STORAGE TESTS.

The descriptions of these experiments are arranged in numbered groups below. Nos. 1, 2, 5, 7, 10 and 12 were planned by Drs. Shear and Stevens, and conducted by the latter. Nos. 4, 6, 8 and 9 were planned and carried out by the writer. Nos. 3 and 11 were planned and conducted by Dr. Stevens and the writer. All these experiments were carried out in 1917. A large crop so filled the station screenhouse in 1918 that it was impossible to do much storage work.

The fruit in the tests of groups 3, 4, 6, 8 and 9 was examined by cup samples by the screeners employed at the station during the fall under the writer's supervision, the inspectors' cup of the New England Cranberry Sales Company being used for sampling. The Sales Company's hand grader was used to facilitate the work.

The "seven-sample" method (described elsewhere in this report, page 106) was used in examining all the fruit spoken of as being stored in crates.

All the tests but those of groups 1, 10, 11 and 12 were conducted in the basement of the station screenhouse, this providing fairly even temperatures.

The groups of storage experiments conducted are as follows: —

¹ Bul. No. 168, Mass. Agr. Expt. Sta., 1916, p. 46.

² Bul. No. 714, U. S. Dept. Agr., 1918, p. 7.

³ Shear, C. L.: End-rot of cranberries. In Journal of Agricultural Research, Vol. 11, No. 2, pp. 35-42, Pl. A, 1917.

⁴ Stevens, Neil E.: Temperatures of the cranberry regions of the United States in relation to the growth of certain fungi. In Journal of Agricultural Research, Vol. 11, No. 10, pp. 521-529, 1917.

1. *The Effect of Temperature on Cranberry Keeping.*

Table 4 shows the amounts of rot that developed among different lots of sprayed and unsprayed Early Black berries kept at different temperatures, some in open and some in closed one-quart cans. All the berries seemed sound when put in the cans. These tests were carried out in Washington, with Brooks and Cooley's temperature apparatus.¹ The softening among the fruit was in all cases greater with the higher temperatures. Table 4 shows like results in tests with Howes berries.

TABLE 4. — *Storage Temperature Tests with Cranberries.*

EARLY BLACK BERRIES FROM HARWICH BOG, STORED SEPT. 28, EXAMINED NOV. 27, 1917.

Sprayed.

TEMPERATURE AT WHICH THE FRUIT WAS STORED (°C.).	STORED IN OPEN CANS.			STORED IN CLOSED CANS.		
	Number of Sound Berries at End of Test.	BERRIES SHOWING DECAY AT END OF TEST.		Number of Sound Berries at End of Test.	BERRIES SHOWING DECAY AT END OF TEST.	
		Number.	Per Cent.		Number.	Per Cent.
0, ...	467	94	16.76	334	175	34.38
5, ...	401	147	26.82	369	213	36.60
15, ...	323	299	48.07	211	345	62.05
20, ...	149	393	72.51	172	356	67.42

Unsprayed.

0, ...	498	131	20.83	523	139	21.00
5, ...	475	174	26.81	406	248	37.92
15, ...	290	311	51.75	276	393	58.74
20, ...	219	411	65.24	280	326	53.80

HOWES BERRIES FROM THE STATION BOG, STORED OCT. 9, EXAMINED DEC. 17, 1917.

0, ...	515	44	7.87	452	74	14.07
5, ...	411	150	26.74	291	219	42.90
15, ...	291	272	48.31	301	210	41.10
20, ...	112	322	74.19	111	450	80.21

¹ Brooks, Charles, and Cooley, J. S.: Temperature Relations of Apple-rot Fungi. In Jour. Agr. Research, Vol. 8, No. 4, pp. 141, 142, 1917.

2. *The Relation of Air Humidity to Cranberry Keeping.*

Table 5 describes three series of humidity tests with cranberries conducted at the station, in Hempel desiccators, in which the air was kept at known humidities by exposure to sulfuric acid of various specific gravities.¹ In the first two series ventilation was supplied the berries every other day by removing the covers of the desiccators and pumping fresh air into their chambers with a bellows. No ventilating was done in the last series. The fruit was all from the station bog and was hand sorted. Five ounces of berries were used in each test in the second series, and four in the third series.

The results of these experiments and of others carried out by Dr. Stevens show no definite relation between the air humidity and the rate of decay among the fruit. Berries kept as well in very moist air as in dryer air, unless they were actually wet. The last column of the table, however, shows that the loss of the berries in weight increased with the decrease in the air humidity. Evidently considerable humidity in the air is needed to prevent drying of the fruit. Under the conditions usually prevailing in Cape screenhouses, however, the humidity is probably sufficient to prevent much loss from drying.

TABLE 5. — *Air Humidity and Cranberry Keeping.*

VARIETY.	Tests began.	Tests ended.	Humidity (Per Cent).	Number of Sound Berries at End of Test.	BERRIES SHOWING DECAY AT END OF TEST.		Loss in Weight during the Test (Per Cent).
					Num-ber.	Per Cent.	
Early Black,	Sept. 13	Oct. 8	100	147	33	18.33	-
			35	173	17	8.95	-
			Varied: 100, 80, 65, 35, 0, in rotation, every other day.	192	13	6.34	-
				167	9	5.11	-
				198	5	2.46	-
				180	12	6.25	-
				156	13	7.69	-
Howes, . . .	Oct. 8	Nov. 13	100	141	10	6.62	.0
			80	153	13	7.83	3.7
			65	128	19	12.93	5.0
			35	134	11	7.59	6.0
			0	132	22	14.29	7.5
			Alternated, 100 and 35, every other day.	121	19	13.57	3.7
				119	21	15.00	3.7
Howes, . . .	Nov. 18	Dec. 19	100	116	13	10.08	.0
			100	112	18	13.85	.0
			80	106	16	13.11	1.5
			65	117	14	10.69	3.0
			35	115	9	7.26	5.0
			35	111	9	7.50	4.5
			0	106	13	10.92	6.0

3. *Ventilation and Cranberry Keeping.*

On September 17 three lots, of two bushels each, of uncleaned, freshly picked cranberries from the same area of the station bog were stored in

¹ The method is fully described by Dr. Stevens in *Phytopathology*, 1916, Vol. 6, No. 6, pp. 428-432.

picking crates under different conditions of ventilation. Lot 1 was placed in a tightly closed trunk; lot 2 was unenclosed in the basement of the screenhouse; and lot 3 was left outdoors every clear, cold night, and kept in the basement the rest of the time. The last lot was much wetted by dews, this probably largely offsetting the benefits of the lower temperatures obtained by the night exposure.

Considerably more spoilage took place among the fruit in the trunk than in the other lots, confirming the findings concerning ventilation given in previous reports. The percentages of berries showing decay at the end of the experiment — November 13 — follow: —

Lot 1,	.	.	.	.	.	.	.	.	.	35.85
Lot 2,	.	.	.	.	.	.	.	.	.	27.88
Lot 3,	.	.	.	.	.	.	.	.	.	28.58

4. *Losses from Decay and from Size Shrinkage of Sound Berries in Closed and in Open Containers compared.*

Table 6 shows the results in this connection with the Howes fruit of grading tests 3 and 4 of group 6. There was almost no shrinkage in the size of the sound berries in the closed crates, while those in the open ones shrunk on an average over 4 per cent. This difference in shrinkage, being due to the difference in ventilation, is probably a fair measure of it. If so, the Beaton crate has practically no ventilation when packed for shipment.

The table shows that the average increase in loss due to decay in the closed crates was less than half the average increase in loss from size shrinkage in the open ones. This is surprising and needs further investigation. The fact that the berries of test 3 were picked in a different place from those in test 4 makes the result especially questionable, for those of test 4 may have been inferior keepers anyway.

An experienced observer ¹ has estimated that Early Black berries held in common storage at a bog for late trade shrink as much as 10 per cent aside from any decay. The difference between the averages of the cup-counts taken at the beginning and at the end of the storage in grading test 1 (Table 9) shows a size shrinkage of about 10 per cent for this variety between October 10 and January 14. This fruit was picked September 20, and its total size shrinkage must have been much more than 10 per cent, for cranberries lose weight in ordinary storage considerably more than twice as fast in early fall as in winter.²

The loss from size shrinkage under conditions of free ventilation is evidently so large, especially in the early fall, that the advisability of making special provisions for ventilating, except where this may aid in maintaining low temperatures, is much reduced. In the writer's opinion, shipping in crates instead of in barrels is, except with poorly colored fruit, desirable more because it reduces mass bruising than because it allows freer ventilation.

¹ Griffith, H. S.: In Ann. Rept. New Eng. Cranberry Sales Co., 1913, p. 20.

² Bul. No. 163, Mass. Agr. Expt. Sta., 1916, p. 16.

5. *Water Storage.*

Storing cranberries in water has been recommended often as a way to keep them a long time. When thus stored they soon soften from smothering.¹

Table 7 describes several tests in which water storage in stoppered bottles was compared with dry storage in tight and in ventilated containers. All the Early Black fruit stored in water softened, while only a part of that stored dry did so. The Howes berries softened less in water than did the Early Black, probably partly because they were picked later, and, as compared with the first two lots, partly because they were stored later, the temperature of the greenhouse basement and therefore that of the water being lower. The berries of the third Early Black lot were probably partly smothered in ordinary storage before they were put in the water. The berries used in the tests were all hand-sorted.

The fruit softened by water storage had much the same peculiar character, described by Dr. Shear and his associates,² that cranberries smothered in dry storage have. They lacked the bitter taste of the fruit smothered dry, however, and were therefore suitable for cooking when taken from the water. Among the berries stored dry, much more softening occurred in the tight containers than in the open ones. This result supports conclusions given in previous reports.

The berries used in the first two series of these tests were only partly colored when stored. Those put in shipping crates were subject to the same temperatures, and were less exposed to the light than those without ventilation, but they colored up very much during the storage, while the color of the others changed little. This shows that ventilation is essential to the coloring of berries picked green. Therefore green or partly colored fruit in particular, should be stored and shipped in ventilated containers.

Table 8 describes water storage experiments with Dill³ cranberries in three different degrees of maturity. Most of the berries in all the different lots softened in the water, somewhat more spoilage occurring among the green than among the ripe fruit.

Unpicked Howes berries at the station bog were kept from freezing with planks and leaves until the bog was winter-flowed on Dec. 13, 1917. Some of this fruit was examined January 1 through a hole cut in the ice, and was then found fresh and crisp. The berries were picked by hand April 1, 1918, before the water was let off, and were all soft then. The writer cut some of them open and found their flesh reddened throughout, their appearance being that of smothered berries.

¹ This name was given by Dr. Shear and his associates to the spoilage of cranberries caused by insufficient ventilation. See Bul. No. 714, U. S. Dept. Agr., August, 1918, p. 4.

² Bul. No. 180, Mass. Agr. Expt. Sta., 1917, p. 237.

³ This variety is grown solely by Mr. Bion Wing of Philips, Me.

TABLE 7. — *Keeping of Ripe Cranberries when stored in Water.*

BERRIES USED.	Test began.	Test ended.	WATER STORED.				DRY STORED.			
			Kind of Water.	CONDITION OF BERRIES AT END OF TEST.			Container.	CONDITION OF BERRIES AT END OF TEST.		
				Sound.	SOFT.			Sound.	SOFT.	
					Number.	Per Cent.			Number.	Per Cent.
Early Black, fresh-picked,	Sept. 13	Oct. 17	Well water,	None	All	100	Stoppered bottle, Peck shipping crate, Peck shipping crate, ¹	571 999 1,009	474 291 242	45.36 22.56 19.34
Early Black, cooled after picking,	Sept. 15	Oct. 17	Well water,	None	All	100	Stoppered bottle, Peck shipping crate,	680 1,027	427 141	38.57 12.08
Howes,	Oct. 13	Nov. 16	{ Boiled water, { Unboiled water,	635 346 ²	346 159 ²	35.27 31.49	Bottle, Peck shipping crate,	710 704	304 207	29.98 22.72
Early Black,	Nov. -	Dec. 19	{ Boiled water, { Unboiled water,	None None	All All	100 100	Stoppered bottle, Peck shipping crate,	277 982	777 382	73.72 28.01

¹ Fruit wetted from time to time.² Part of the berries in this test were lost by accident and not counted.

TABLE 8. — *Effect of Water Storage on the Keeping of Dill Cranberries of Different Degrees of Ripeness. Period of Storage, September 29 to November 22.*

DEGREE OF RIPENESS.	Kind of Water used.	CONDITION OF BERRIES AT END OF TEST.		
		Sound.	SOFT.	
			Number.	Per Cent.
Ripe, ...	Boiled, ...	57	226	79.86
Ripe, ...	Unboiled, ...	82	223	73.11
Half ripe, ...	Boiled, ...	57	302	84.12
Half ripe, ...	Unboiled, ...	84	259	75.51
Green, ...	Boiled, ...	47	431	90.17
Green, ...	Unboiled, ...	47	388	89.20

6. *The Relative Keeping of Graded and Ungraded Cranberries.*

Table 9 describes five experiments in this connection. In each of these the two lots of fruit were obtained by dividing the contents of picking crates by alternate dipping with a quart measure. Only berries coming from the separator spout were used, those going into the boxes of the machine not being included. The spacing of the grader was fifteen thirty-seconds of an inch. A board seven-sixteenths of an inch thick was in the grader frame in place of the grader when the second lot of each test was run through the machine. Further information about the tests follows:—

Test 1.—All this fruit was picked on September 20 in the same location on the station bog. Both lots were put through a Hayden separator October 2, and run into boxes placed close up to the separator spouts instead of barrels. The grader took out about 30 per cent of the quantity of fruit in the first lot. Both lots were screened October 6, and run from the screens into bushel picking crates, all of which were of the same size and construction, and were placed close up to the mouths of the screen. The screeners were exchanged between the two screens when the two lots were about half looked over, so as to have the cleaning of the lots as uniform as possible. The crates were left open during the storage, four crates of the graded and five of the ungraded fruit being used.

Test 2.—All this fruit was gathered in the same place on the station bog on September 27. On October 25 both lots were put through a separator, being run from the spouts of the machine into boxes placed close up to them. The grader took out about 30 per cent of the first lot. When the fruit was screened, October 26, both lots were run into barrels from the mouths of the screen as usual, no easers¹ being used. The writer

¹ "Easer" is a term applied to any device for preventing the bruising of berries by breaking their fall.

packed both lots in barrels, measurements being taken to heap them exactly alike before they were headed up. Two barrels of each lot were used in the test.

Test 3. — These berries were picked on one of Dr. Charles R. Rogers' bogs at East Wareham on October 3. They were kept in the basement of the station screenhouse just as they came from the bog from October 3 until November 25, when they were run through a separator, the grader taking out about 27 per cent of the fruit in the first lot. Both lots were run into bushel picking crates placed up close to the spouts of the separator. When the berries were screened, November 26, they were run from the mouths of the screen into the Beaton crates placed close up to them. The fruit of each lot was taken into the warm screening room a crateful at a time, and each crate was taken out as soon as it was filled. The crate covers were nailed on closely, as if for shipment, during the storage, three crates of the graded and five of the ungraded fruit being used.

Test 4. — Part of this fruit came from one of Dr. Rogers' bogs and part from the station bog. It was picked September 26 and October 3, and was all stored in the basement of the station screenhouse just as it was picked until it was divided on November 28. The grader took out about 23 per cent of the quantity of the first lot. Both lots were run into bushel picking crates placed close to the spouts of the separator. When the fruit was screened, November 30, it was run from the mouths of the screen into picking crates placed close to them, and was then stored in the same crates. Each lot was taken into the warm screening room a bushel at a time, and each crateful was taken out as soon as screened. The crates were left open during the storage, four crates of graded and six of ungraded fruit being used.

Test 5. — This fruit was picked on the station bog September 27, and was stored just as it came from the bog in the basement of the screenhouse until it was divided on December 3. Both lots were run through the separator December 5, and were run into bushel picking crates placed close up to the spouts of the separator. The grader took out about 17 per cent of the fruit of the first lot. When the fruit was screened, December 5, it was run from the mouths of the screen into the barrels as usual, no easers being used. The berries were taken into the warm screening room a bushel at a time, and each barrel was taken out as soon as screened. The barrels were all shaken thoroughly and heaped as nearly alike as possible before they were headed up, the distance between the head, resting on the heaped berries, and the chimes being carefully measured in every case. Two barrels of graded and three of ungraded fruit were used.

The fruit of each of these tests except the first was carefully sampled and examined at the beginning of the storage period. Column 8 of the table gives the percentages of berries then found showing decay. These must be subtracted from those in the last column to get a fair idea of the

relative keeping of the graded and ungraded fruit. The latter kept somewhat better in every case, this result nullifying that of experiments previously reported.¹ In most of these tests the berries were screened and sampled both at the beginning and at the end of the storage. The average cup-counts given in the table show how the sound berries shrink in size in ventilated containers.

¹ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, pp. 208-211.

TABLE 9. — *Tests of the Relative Keeping of Graded and Ungraded Cranberries.*

Test No.	VARIETY.	Container.	Percentage of Berries taken out by Grader.	Period of Storage.	AVERAGE CUT-COUNTS OF SOUND BERRIES.		PERCENTAGE OF BERRIES SHOWING DECAY.	
					At Beginning of Test.	At End of Test.	At Beginning of Test.	At End of Test.
1	Early Black,	Bushel picking boxes, . . .	30 Not graded	} Oct. 10 to Jan. 14	{ 107 126½	120 139	-1 -1	49.97 51.69
2	Early Black,	Barrels, . . .	30 Not graded	} Oct. 29 to Jan. 14	{ 105 117	-1 -1	7.13 8.58	62.46 56.82
3	Howes,	Beaton half-barrel crates, . . .	27 Not graded	} Nov. 27 to Feb. 1	{ 112½ 132	113 132	5.68 7.12	30.26 28.90
4	Howes,	Bushel picking boxes, . . .	22.5 Not graded	} Dec. 1 to Feb. 1	{ 112 125	116 131	7.44 6.29	30.45 26.47
5	Howes,	Barrels, . . .	17 Not graded	} Dec. 5 to Jan. 16	{ 106 122	-1 -1	8.21 11.47	25.83 26.16

1 Not determined.

7. *The Relative Keeping of Wet and Dry Cranberries.*

Table 10 describes two experiments in this connection with fruit from the station bog. In each test the fruit was stored in bushel picking crates the day it was picked, four crates of each lot of the Early Black and six of each lot of the Howes berries being used. The results confirm those of tests heretofore reported.¹

TABLE 10. — *Relative Keeping of Wet and Dry Cranberries.*

Test.	VARIETY.	Time of Day the Fruit was picked and stored.	Temperature at which the Fruit was picked and stored (°C.).	Condition in which Fruit was picked and stored.	Period of Storage.	Percentage of Berries showing Decay at End of Storage.
1	Early Black, . {	7 to 8 A.M. 11 A.M. to 12 M.	14 to 17 31	Wet Dry }	Sept. 19 to Nov. 13	{ 47.88 33.60
2	Howes, . . {	7 to 8 A.M. 4 to 4.15 P.M.	13 to 16 —	Wet Dry }	Sept. 26 to Nov. 13	{ 39.86 13.57

As it was thought that berries picked wet might keep less well than those picked dry because of being bruised more in the process of picking, an experiment in which one of the lots was wetted in the crates after picking was tried. The berries were of the Early Black variety, and were picked on September 14 and stored in bushel picking crates. There were three crates in each lot. On November 14 the berries were examined for rot, and 66.34 per cent were found showing decay in the wetted lot against 45.85 per cent in the dry one. The result clearly shows the harmful effect of wetness among stored cranberries.

8. *The Effect of an Admixture of Cranberry Leaves on the Keeping of the Berries.*

The fruit of two varieties, Early Black and Howes, was tried in this connection. The berries were picked and stored September 22, in bushel picking crates, twelve crates of each variety being used, six with leaves and six without. The berries and leaves were put into the crates in alternate layers, and each layer of leaves was mixed with the berries beneath it by careful shaking, this probably doing little or no harm to the fruit. Three quarts of leaves were used in each crate to which they were added. The berries were examined for rot on December 26 and 27. The examination showed the following percentages of decay:—

Early Black: with leaves, 62.74; without leaves, 47.77.
Howes: with leaves, 42.59; without leaves, 27.36.

¹ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, pp. 201-204.

These results strongly confirm those previously reported.¹ It was noticed that a large percentage of the rot spots shown by berries with which leaves were mixed were quite small.

9. *The Effect of an Admixture of Decayed Early Black Cranberries on the Keeping of Berries of that Variety.*

Two lots of berries in quart cans were used in this test. There were 18 cans in each lot. The berries were examined and put in storage during the days of October 18 to 23. The decayed berries put in lot 2 were entirely soft but unbroken. The can covers were tight but not sealed. Lot 1 contained 9,105 sound berries, and lot 2, 4,957 sound berries mixed with 5,541 rotten ones. On December 28 the berries were examined. Lot 1 contained 3,823, and lot 2, 1,159, sound berries. The percentages of berries found to have wholly or partly softened during the storage were as follows: lot 1, 58.01; lot 2, 76.62. The admixture of rotten fruit apparently promoted decay among the sound berries; but this result contradicts a like test with Howes fruit previously reported.²

10. *Berries separated with Hayden and with White Machines compared as to Keeping Quality.*

Boxes of fruit from a commercial lot of Howes berries were divided by dumping, and one part was cleaned with a Hayden and the other part with a White separator on November 12. The fruit from each machine was packed in a half-barrel and shipped to New York. It was examined there December 12, 20.9 per cent of that cleaned with the Hayden separator and 21.8 per cent of that cleaned with the White then showing decay. This result accords with that of like tests heretofore reported³ in showing little difference in the injury caused by the two kinds of separators.

11. *Barrels v. Crates as Containers for shipping Cranberries.*

The two following shipping tests were conducted:—

(a) *New York Shipment.*—This fruit was gathered on one of Dr. Rogers' bogs on October 3 and kept in picking crates, just as it came from the bog, in the basement of the station screenhouse until November 16, when the contents of the crates were divided into two lots by alternate dipping with a quart measure. Both lots were put through a Hayden separator November 17, picking crates being placed close up to the separator spouts to receive the berries, instead of barrels. Only the fruit coming from the spouts of the separator was used on either side of the test. A grader with a thirteen-thirty-second-inch spacing was used with both lots. The berries were screened November 17, easers being used with those that were barreled, while Beaton crates were placed close to

¹ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, pp. 205, 206.

² Bul. No. 168, Mass. Agr. Expt. Sta., 1916, p. 19.

³ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, pp. 206-208.

the mouth of the screen to receive the other lot. There were two barrels in one lot and four half-barrel crates in the other. Both lots were packed November 17. They were left in the basement of the screenhouse, the barrels on the bilge, until November 22, when they were shipped to New York. One crate was broken in transit. The rest of the shipment was examined December 12, as shown in Table 11, the result distinctly favoring the crates.

TABLE 11.—*Barrels v. Beaton Crates as Containers for shipping Cranberries.**Beaton Crates.*

Crate.	LOCATION IN THE CONTAINER FROM WHICH THE SAMPLE WAS TAKEN.	Sound Berries in the Sample.	BERRIES SHOWING DECAY.	
			Number.	Per Cent.
1	$\frac{1}{4}$ middle, ...	114	8	6.6
	$\frac{1}{4}$ edge, ...	85	14	14.1
	$\frac{1}{2}$ middle, ...	141	12	7.8
	$\frac{1}{2}$ edge, ...	102	6	5.5
2	$\frac{1}{4}$ middle, ...	114	19	14.3
	$\frac{1}{4}$ edge, ...	122	17	12.2
	$\frac{1}{2}$ middle, ...	106	14	11.7
	$\frac{1}{2}$ edge, ...	103	6	5.5
3	$\frac{1}{4}$ middle, ...	116	16	12.1
	$\frac{1}{4}$ edge, ...	143	10	6.5
	$\frac{1}{2}$ middle, ...	96	12	11.1
	$\frac{1}{2}$ edge, ...	86	10	10.4
Totals, ...		1,328	144	9.8

Barrels.

Barrel.				
1	Top, ...	114	18	13.6
	$\frac{1}{4}$ middle, ...	107	19	15.1
	$\frac{1}{4}$ stave, ...	151	18	10.7
	$\frac{1}{2}$ middle, ...	100	15	13.0
	$\frac{1}{2}$ stave, ...	110	13	10.6
2	Top, ...	210	37	15.0
	$\frac{1}{4}$ middle, ...	113	19	14.4
	$\frac{1}{4}$ stave, ...	105	17	13.9
	$\frac{1}{2}$ middle, ...	109	16	12.8
	$\frac{1}{2}$ stave, ...	121	16	11.7
Totals, ...		1,240	188	13.1

(b) *Chicago Shipment.*—The two lots of Early Black berries used in this test were picked in the same place on the station bog some time between September 20 and 28, the contents of picking boxes being divided by alternate dipping with a quart measure on October 25 to make the two lots. The berries were stored in the basement of the screenhouse as they came from the bog until they were divided. Both lots were put through a Hayden separator October 26, and were run from the spouts of the machine into boxes placed close to them. Both lots were

graded with a thirteen-thirty-second-inch grader. They were screened in the afternoon of October 26 and the morning of the 27th. Those packed in barrels were run from the mouths of the screen as usual, no easer being used, while the other lot was run from the mouths of the screen into crates placed up close to them. The berries were packed for shipment October 27 and left in the basement of the screenhouse until November 1, when they were taken to Wareham in an auto truck and shipped to Chicago on top of a carlot of berries. The two barrels and four crates included in the test were examined in Chicago November 15, the crates showing 18 per cent of spoiled fruit, and the barrels 22 per cent.

12. *Shipping Cranberries in Chaff v. shipping them in the Clean Condition.*

Table 12 shows the experience with fruit of the McFarlin and Middleborough varieties packed at Wareham October 26 and shipped to Chicago. The first lot of each variety was shipped in the chaff. Each second lot was carefully separated and sorted before shipment, and the shrinkage noted. All the lots were run through a separator at Chicago on November 15, and the shrinkage again noted. With both varieties the total loss of berries was greater with those cleaned before than with those cleaned after shipment. This was especially noticeable with the Middleborough variety, which contained no frosted berries and therefore gave a more reliable test.

Shipping in chaff involves the extra expense of freight charges and containers for the chaff and rotten berries which would be taken out in cleaning. On the other hand, fruit shipped in the chaff may be held in storage and run through a separator as sold. Hand-sorting not being necessary, the cost of preparing for sale is materially reduced.

TABLE 12. — *Shipping Cranberries in Chaff v. shipping them in the Cleaned Condition.*

VARIETY.	Lot.	CONTAINERS.		Condition in which Fruit was shipped.	Shrinkage in separating and sorting before Shipment (Per Cent).	Shrinkage in separating at Chicago (Per Cent).	Total Shrinkage (Per Cent).
		Kind.	Number.				
McFarlin, . .	1	½ barrel boxes,	5	In chaff, Separated and screened, .	—	28.7	28.7
	2	½ barrel boxes,	5		20	10.2	30.2
Middleborough, .	1	½ barrel boxes,	5	In chaff, Separated and screened, .	—	27.0	27.0
	2	½ barrel boxes,	5		20	15.5	35.5

INSECTS.

The Span Worm (Epelis truncataria var. faxonii Minot).

In 1917 a bog under the writer's observation near East Wareham was reflowed June 20 while the moths of both sexes of this insect were numerous on a large share of it. The water was let off June 23. It either destroyed or drove ashore all the moths, very few being seen afterwards, but it apparently did little or no harm to the eggs which had been laid before the flooding, for the worms appeared on the bog in great numbers in July. When the worms were small, this infestation was treated once with 6 pounds of arsenate of lead paste to 50 gallons of water with great success, no noticeable injury from what started as a severe infestation appearing afterward. But few of the worms could be found by sweeping the bog with an insect net a few days after the spraying.

This insect did much harm on a bog in Carver in early August, 1918. It worked late because the winter flowage had been held until near the 1st of June, the pupæ enduring this prolonged submergence.

The Cranberry Root Grub (Amphicoma vulpina Hentz.).

The writer gives the above common name to a grub found occasionally in great numbers in the sand covering of cranberry bogs, where it works much like the root worm (*Rhabdopterus picipes*), feeding mainly on the small roots. The infestation usually is confined to limited areas, seldom extending in severity in one patch over more than 15 or 20 square rods at most. The areas affected are often very irregular, but sometimes quite circular. Occasionally the injury is so severe that the vines are entirely killed in patches, the roots being so eaten that they can be rolled back easily like a rug. More often the infested area looks yellowish and sickly, the vines failing both to grow well and to produce much fruit, this condition usually lasting several years. Vines thus affected often die suddenly in patches, or their growing tops and green berries wither, this happening only in periods of hot, dry weather. It probably takes vines that are not killed two or three years to recover after the insects finish their work and disappear, as they finally do.

The grubs look somewhat like those common in gardens, but are smaller and with a thin coat of fox-red hair which is well distributed over the body. They are from 28 to 30 millimetres long when mature, but all sizes from 8 millimetres long up are commonly found working together, the various sizes perhaps being of different broods.

The writer has never reared the adults of this species, but he found associated in the soil with the grubs of one infestation great numbers of both sexes of the beetles of *Amphicoma vulpina* Hentz.¹ Many pupæ and pupa skins of this species were also present. These beetles were first found July 5, 1917. They were in a dormant condition, most of them being about 3 inches below the surface of the sand. They were present in about the same numbers and condition on July 11. On July 17 these

¹ Identified by Mr. A. I. Bourne of the Massachusetts Agricultural Experiment Station.

conditions were mostly the same, but three of the beetles were found crawling around on the vines above ground. On July 21 the beetles were distinctly less abundant in the sand than before. These beetles are about five-eighths of an inch long. The males have quite a coat of fox-red hair. The females also have a hairy covering, but it is thinner and more olive-colored, and the hairs are much shorter. Both sexes are usually sluggish in their movements, but they sometimes were seen to fly well. When either the beetles, taken from the soil, or the grubs are placed on sand they bury themselves at once.

The work of this insect was noted as that of a species of *Lachnosterna* in the report of the cranberry investigations of 1911.¹

The Spittle Insect (Clastoptera vittata Ball²).

This insect abounds on occasional cranberry bogs every year, it often being so prevalent that its spittle will wet one's shoes like a heavy dew. It commonly infests dry bogs, and apparently also those that are winter-flowed but not reflowed. It is said to winter in the egg stage. In this stage it seems to endure the long flooding. The writer has not yet found it abundant on a bog reflowed according to the usual practice.

The season was very late in 1917, and the young nymphs were found just starting their spittle on cranberry vines on June 13. The spittle masses were abundant and well-developed on several bogs on June 25. They were plentiful from then until after mid-July, but had nearly disappeared by the 20th of that month. The first grown insect obtained in confinement emerged July 12. The adults of both sexes came out rapidly from the 15th to the 19th. These insects are from about one-eighth to nearly three-sixteenths of an inch long. They are glossy, the males being black and the females black with yellow stripes. They jump lively when disturbed.

In 1918 the season was much earlier than in 1917, and the small masses of spittle were first found May 28. Judging by the size of some of the masses the insect must have begun hatching four or five days before this. It was noted July 10, 1918, that nearly all the adults had emerged.

Some cranberry growers have long considered this species very harmful when abundant. To determine this point the writer marked several hundred infested uprights with blue, and as many uninfested ones with red, yarn a little after mid-July, 1917. These uprights were examined December 7. The results, shown in Table 13, give striking proof that this is a very injurious insect, and ought to be controlled wherever it becomes abundant on a bog.

A heavily infested area was sprayed July 5, 1917, with Black-Leaf 40, 1 part to 400 parts of water, resin fish-oil soap being added at the rate of 2 pounds to 50 gallons. The insects were then nearly full-grown and well enveloped in spittle. The writer examined the treated area July 6, and found most of the insects had been killed and most of the spittle had dried up.

¹ Twenty-fourth Ann. Rept., Mass. Agr. Expt. Sta., Part I, p. 22, 1912.

² Called *C. proteus*, Fitch, in the Ann. Rept. of the Cape Cod Cranberry Growers' Assoc., 1917, p. 8.

On June 2, 1918, an infested area was sprayed with Black-Leaf 40, 1 part to 800 parts of water, soap being added as in 1917. The nymphs were small and the treatment was very effective, practically all the spittle masses disappearing, while they remained abundant on the untreated surrounding parts of the bog.

In 1918 the writer reared adults of this species from the following:—

1. *Gaylussacia frondosa*, Torr. & Gray.
2. *Gaylussacia resinosa*, Torr. & Gray.
3. *Vaccinium vacillans*, Solander.
4. *Vaccinium corymbosum*, L.
5. *Vaccinium macrocarpon*, Ait.
6. *Andromeda ligustrina*, Muhl.
7. *Leucothoe racemosa*, Gray.
8. *Cassandra calyculata*, Don.

The insect infested all these species except *V. corymbosum* very abundantly. As some of these plants grow in great abundance around or near most Cape bogs, they furnish a large source of infestation for them. As the insect does not infest reflowed bogs, however, its progress from the uplands onto the bogs must be very slow.

Clastoptera proteus, Fitch, has been defined to include a variety of forms.¹ The writer thinks that the forms (subspecies *flava* and subspecies *nigra*, var. *a*, of Ball) which Professor Osborn bred from dogwood² really belong to species distinct from the one (subspecies *vittata* and subspecies *nigra*, var. *b*, of Ball) infesting the cranberry and other plants of the heath family. The writer has seen some of Professor Osborn's specimens. Of these, one female and one male belonged to Ball's subspecies *flava*, and two males to subspecies *nigra*, var. *a*. The writer has reared hundreds of specimens of both sexes from ericaceous plants. Nearly all his females belong to subspecies *vittata*. A few of his females and all his males belong to subspecies *nigra*, var. *b*. He has captured specimens of *vittata* and *nigra*, var. *b*, in coition. The pronotum of *vittata* and of *nigra*, var. *b*, always has a slight median longitudinal sulcus. None of Osborn's specimens were at all sulcate longitudinally on the middle of the pronotum, the two males of *nigra*, var. *a*, even being slightly carinate longitudinally there instead. Further structural differences should be looked for in the male genitalia.

The Cranberry Tip Worm (Dasyneura vaccinii Smith).

The Proctotrypid, heretofore reported³ as the most important parasite of this species, has been identified⁴ as *Ceraphron pallidiventrtris* Ashm. It was bred from the maggots in great numbers in 1917 as it had been in 1916.

¹ Ball, E. D.: Proc. Iowa Acad. Sci., III., 1895, pp. 186, 187.

² Bul. No. 254, Maine Agr. Expt. Sta., 1916, p. 284.

³ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, p. 226.

⁴ By Mr. A. B. Gahan of the Bureau of Entomology.

The Gypsy Moth (Porthetria dispar L.).

Early in January, 1917, several batches of the eggs of this insect, collected from trees shortly before, were submerged in two or three feet of water in a pond, two lots being left in the basement of the screenhouse as a check on the hatch of the others. The hatch of those kept in the basement was nearly perfect, while less than 1 per cent of those taken from the pond May 16, and none of those removed May 24, May 29 or June 2, hatched. All these eggs were put on sand in pails when taken from the water, and kept in the upper part of the screenhouse, as were also those from the basement. A lot taken from the pond June 7 was put at once on the station bog, the egg masses being spread under the vines, with care to place them as a moth might lay them. This lot was observed until July 4, and but one egg was known to hatch, a newly hatched worm being found on a vine above the eggs June 21. These results confirm those of former years in showing that the eggs do not endure very late holding of the winter water.

Mr. C. W. Minott of the Bureau of Entomology and the writer cooperated in an experiment at the Wankinco bog in 1917, to determine the amount of the wind drift of the first-stage caterpillars. A horizontal tanglefoot-covered screen was used. This was placed 583 feet on its south side, 837 feet on its northeast side, and 635 feet on its northwest side from the upland. It covered $53\frac{1}{2}$ square feet, and during the wind-drift period caught two of the larvæ. If this shows fairly the wind drift onto the central part of the bog, 1,634 gypsy worms per acre blew onto it during the season. This result is significant, as the bog is so large and its environs were so little infested in the early spring that it seemed doubtful if the experiment would pay.

On June 15, 1917, a grower told the writer he had recently successfully treated gypsy caterpillars floating on the flowage of some bogs with kerosene. He used 5 gallons to 6 acres, and poured it on the water on the windward side. The worms must have been fully a third grown.

On June 9 the writer sprayed oak bushes much infested with gypsy caterpillars with Black-Leaf 40 used at the rate of 1 part to 400 parts of water, with resin fish-oil soap added at the rate of 2 pounds to 50 gallons. The worms were in their second, third and fourth stages, being from 6 to 15 millimetres long, and the spray killed all it hit. Other bushes covered with gypsy worms were sprayed with Black-Leaf 40 used at the rate of 1 part to 800 parts of water, with soap as before. This treatment was partially effective, but very many caterpillars survived it. On June 19 infested bushes were sprayed with Black-Leaf 40 used at the rate of 1 part to 400, soap being added as before. The caterpillars were in their third, fourth and fifth stages, being 10 to 22 millimetres long, and the treatment killed most of them, though many of the larger ones survived. Nearly full-grown caterpillars were sprayed July 5 with Black-Leaf 40 used at the rate of 1 part to 200, with soap as before. This was not effective.

All these tests were tried in sunny weather. Judging by their results, the 1 to 400 Black-Leaf 40 spray kills the worms in their early stages, but is of no use when they are nearly full-grown. One part to 800 parts of water is too weak at any time. Further experiments may show that a medium strength, such as 1 part to 600, will kill the very young caterpillars.

These conclusions are of special interest in relation to the recent developments in the control of the black-head fireworm.

The Black-Head Fireworm (Rhopobota vacciniana (Pack.)).

This pest was well controlled in several 1917 tests where Black-Leaf 40 was used at the rate of 1 part to 400 parts of water, with 2 pounds of resin fish-oil soap to 50 gallons added. After this treatment the infestation always was greatly reduced and the worms were found dead among the sewed-up vines in great numbers. The plots treated with the 1 to 800 Black-Leaf 40 spray were not well located to show results, the infestation in no case proving great enough to hurt the vines around them much.

This insecticide must be tried more thoroughly before we can tell what strength to use under all conditions, but it certainly has displaced arsenate of lead as a control for this insect. It is expensive, costing about \$7 per acre per application when used at the rate of 1 part to 400 of water. The number of applications advisable depends on how severe the infestation is and how well it can be curbed by reflowing. While this spray checks either brood, it can as a rule be used more profitably against the first than against the second.

Control of the gypsy moth and the fireworm with the same application is feasible, as the time for the first treatment of the first brood of the fireworm is usually not too late for spraying the gypsy. When both insects are treated, the Black-Leaf 40 must be used as strong as 1 part to 600 of water, and 1 to 400 probably will pay better. Treatment of the spittle insect, the gypsy moth and the first brood of the fireworm with the same application of Black-Leaf 40 is practicable on bogs that are winter flowed but not reflowed.

The use of arsenate of lead with the Black-Leaf 40 in spraying for the fireworm and the gypsy moth is probably advisable, for the arsenate whitens the spray and so marks where it is applied, thus reducing the liability of leaving areas unsprayed. It also adds to the insecticidal value of the spray, and, as shown elsewhere in this report, gives it a fungicidal value when it is used on Early Black vines. Whale-oil soap is preferable to resin fish-oil soap for use with Black-Leaf 40, especially if arsenate of lead is added, for the arsenate and the resin soap make a burning combination.

Several fireworm-infested bogs on the Cape had their winter flowage held until the 10th of July, 1918. While this greatly reduced the infestation, there was a considerable hatch in every case after the water was let

off. It is now doubtful if late holding can be relied on to eradicate the pest entirely unless it is continued to the 1st of August. The most successful treatment applied on large bogs in 1918 was that of letting the winter flowage off about June 1 and flooding again from three weeks to a month later. This has been reported as very effective heretofore.¹

In 1917 the first brood was first found hatching on June 4, the spring having been very late and cold. At this time none of the worms observed seemed more than two days old. This is the latest date for the beginning of the hatch the writer has ever noted.

The Cranberry Fruit Worm (Mineola vaccinii Riley).

In 1917 the eggs of this insect showed a range in Chalcidid (*Trichogramma minuta*) parasitism of from 83 to 89 per cent on dry bogs, and from 29 to 88 per cent on those with winter flowage. In 1918 the range was from 36 to 89 per cent on dry bogs and from none to 15 per cent on flowed ones.

The fruit worm did much more injury in 1917 than in 1916.

On June 27, 1917, the writer covered large numbers of fruit-worm cocoons, in quart cans partly filled with moist sand, with measured and uniform one-third inch, one-half inch and 1 inch depths of sand. Checks of cocoons without any covering were kept for comparison. The cocoons had been kept in good condition on sand in cans during the preceding fall, winter and spring, and it is certain that when these tests were started the worms had all either pupated or been destroyed by the formation of the parasite pupæ. As in like tests previously reported,² both the moths and parasites emerged through the one-third and one-half inch coverings fairly freely, but the inch covering smothered them almost completely.

Large numbers of cocoons of fruit worms were buried under a measured inch of sand in the late fall of 1917. Most of the worms left their cocoons, worked their way up through the sand, and in some cases built very meager secondary cocoons after reaching the surface. The pupæ of the worms and parasites were formed on or near the surface.

These results show that the fruit worm may be smothered by heavy sanding, but that the sand must be applied after pupation to be effective. As shown heretofore,³ pupation is not completed until the middle of June, and bogs cannot be sanded then without doing much injury.

The difference in the results obtained with this insect by covering cocoons heavily with sand before the worms pupate as compared with like covering after pupation may explain why the writer⁴ had so much greater success than Scammell⁵ in smothering the girdler (*Crambus hortuellus* Hübner). The writer applied the sand late in May, while Scammell applied it in November. The girdler usually pupates in the last half of

¹ Twenty-fifth Ann. Rept., Mass. Agr. Expt. Sta., Pt. I, 1913, p. 232.

² Bul. No. 180, Mass. Agr. Expt. Sta., 1917, p. 228.

³ Bul. No. 168, Mass. Agr. Expt. Sta., 1916, p. 40.

⁴ Twenty-fourth Ann. Rept., Mass. Agr. Expt. Sta., Pt. I, p. 19, 1912.

⁵ Bul. No. 554, U. S. Dept. of Agr., 1917, p. 18.

May and very early June, if the winter water is let off early, as it was at the bog where the writer made his tests. The writer observed Scammell's experiments and saw nothing in them to criticize.

The fruit-worm injury in 1918 was the least of any season in the writer's experience. This, after so severe a winter, seemed surprising.¹ Its injury to the station crop was estimated to be 3 to 4 per cent.

The Greasy Cutworm (Agrotis ypsilon Rott.).

In a previous report² a destructive visitation of the fall army worm (*Laphygma frugiperda* S. & A.) on cranberry bogs, following closely and evidently somehow caused by the removal of the winter flowage in mid-July, was noted. This season a similar visitation by the greasy cutworm (*Agrotis ypsilon* Rott.) occurred in August on a large part of the Wankineo bog, the bog having been flowed from early June to July 10. The blackish worms in their feeding dropped a litter of uneaten leaf fragments onto the sand under the vines. They were first seen about August 10, many being then considerably grown, and they disappeared on the bog about August 24. They seemed to be cannibals when confined in tightly closed cans in numbers together, for they became rapidly fewer under such conditions without any other evident reason. They pupated in confinement in late August and early September, and the moths emerged from September 18 to October 2.

The writer thinks there may be several more species that on occasion will infest cranberry bogs, bared of their winter flowage in midsummer, in this way. Scammell's explanation that the moths of the fall army worm seem to be attracted to bogs recently bared of the flowage, and there lay their eggs in preference to bogs from which the flowage was removed at the normal time, is probably correct for that insect and other species as well. Observations made by the writer in 1917 on a bog in Plymouth support this opinion. The winter flowage was let off this bog August 10, and a few days later great numbers of moths were found among the vines on all parts of it. The moths were of the three following species, most of them being of the first two:—

1. *Nomophila noctuella* S. V.
2. *Drasteria erechtea* Cram.
3. *Autographa falcigera* var. *simplex* Gn.

These moths were not noticed on any bog that had the winter flowage off early. No worm infestation developed later where the moths appeared. The cranberry may not be a food plant of any of the three species, or the moths may have laid most of their eggs before they came onto the bog.

¹ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, p. 227.

² Bul. No. 180, Mass. Agr. Expt. Sta., 1917, p. 232.

RESANDING.

The 1918 experience with two plots on the station bog that have not been sanded since the fall of 1909 is shown in Table 14. The check areas in each case were adjacent to and on different sides of the plot. The berries were of the Early Black variety, and were picked and placed in storage September 16. The fruit was stored in bushel crates, 8 bushels being used in each case, and was examined December 17 to 19 by the "seven-sample" method.

The fruit from the plots kept distinctly better than that from their checks in nearly every case, this result contradicting that of 1916 with fruit from these areas.¹ These plots yielded as heavily on the average as the surrounding bog until 1916.² Table 15 shows that since 1915 their average productiveness has fallen distinctly below that of their checks. For the past three years the vines on these plots have been much thinner than those of the surrounding bog.

TABLE 14. — *Sanding Plots in 1918. Effect of Resanding on Quantity and Quality of Cranberries.*

PLOTS AND CHECKS.	Area (Square Rods).	Resanded.	Yields per Square Rod (Bushels).	Percentage of Berries showing decay at End of Storage.
V, ...	9	Not since November, 1909, . .	1.59	31.25
V (check 1), ...	6	Spring of 1912, fall of 1914 and spring of 1917, ...	2.33	31.89
V (check 2), ...	6	Spring of 1912, fall of 1914 and spring of 1917, ...	2.56	38.43
V (check 3), ...	6	Spring of 1912, fall of 1914 and spring of 1917, ...	2.22	44.54
O, ...	9	Not since November, 1909, . .	1.39	21.65
O (check 1), ...	6	Fall of 1911, fall of 1914 and spring of 1917, ...	2.11	25.87
O (check 2), ...	6	Fall of 1911, fall of 1914 and spring of 1917, ...	1.72	29.31
O (check 3), ...	6	Fall of 1911, fall of 1914 and spring of 1917, ...	2.03	24.05

TABLE 15. — *Productiveness of Sanding Plots V and O in 1916, 1917 and 1918.*

PLOTS AND CHECKS.	Resanded.	YIELDS PER SQUARE ROD (BUSHEL).			
		1916.	1917.	1918.	Average for Three Years.
V, ...	Not since 1909, ...	.93	.60	1.59	1.04
V (checks), ...	Thrice since 1909, ...	1.39	.65	2.37	1.47
O, ...	Not since 1909, ...	.93	.63	1.39	.98
O (checks), ...	Thrice since 1909, ...	1.24	.63	1.95	1.27

¹ Bul. No. 180, Mass. Agr. Expt. Sta., 1917, p. 219, Table 18.² Bull. No. 168, Mass. Agr. Expt. Sta., 1916, p. 27, Table 15.

FERTILIZERS.

Tables 16 and 17 show the results had with the station bog fertilizer plots in 1917 and 1918, respectively. The area of each plot is 8 square rods, and the variety treated, the Early Black. In 1917 the fertilizers were applied on June 29 and 30, and the berries picked on September 17 and 19. Seven bushels were used in each of the storage tests. In 1918 the fertilizers were applied on June 8. Eight bushels of berries from each plot were examined for rot.

Plots 1, 5, 9, 13, 17 and 21 are all untreated checks. The meanings of the symbols used in the tables are as follows:—

- 0 = Nothing.
 N = 100 pounds nitrate of soda per acre.
 P = 400 pounds acid phosphate per acre.
 K = 200 pounds high-grade sulfate of potash per acre.
 L = 1 ton of slaked lime per acre.
 Kel = 200 pounds muriate of potash per acre.
 $N_{1\frac{1}{2}}$ = 150 pounds nitrate of soda per acre.
 N_2 = 200 pounds nitrate of soda per acre.
 $P_{1\frac{1}{2}}$ = 600 pounds acid phosphate per acre.
 P_2 = 800 pounds acid phosphate per acre.

In combination they mean, for example, $N_2PK=200$ pounds of nitrate of soda+400 pounds of acid phosphate+200 pounds of high-grade sulfate of potash per acre.

TABLE 16. — *Fertilizer Plots in 1917. Condition and Relative Keeping Quality of the Berries.*

Plot.	FERTILIZER.	Yields per Square Rod (Bushels).	PERCENTAGE OF BERRIES SHOWING DECAY.		Percentage of Sound Berries that became more or less Rotten during Storage.
			October 4.	December 8 and 10.	
1	O, ...	1.21	—	—	—
2	N, ...	1.21	—	—	—
3	P, ...	1.28	—	—	—
4	K, ...	1.33	—	—	—
5	O, ...	1.33	—	—	—
6	NP, ...	.94	—	—	—
7	NK, ...	.81	29.33	—	—
8	PK, ...	.92	22.18	—	—
9	O, ...	.69	8.95	—	—
10	NPK, ...	.63	16.47	—	—
23 ¹	O, ...	.58	—	—	—

¹ This plot was dressed with leaf mold in 1916.

TABLE 16. — *Fertilizer Plots, etc.* — Concluded.

Plot.	FERTILIZER.	Yields per Square Rod (Bushels).	PERCENTAGE OF BERRIES SHOWING DECAY.		Percentage of Sound Berries that became more or less Rotten during Storage.
			October 4.	December 8 and 10.	
11	NPKL, ²	.83	33.40	63.38	44.97
12	NPKel, ...	1.05	20.74	—	—
13	O, ...	1.06	9.75	36.63	29.78
14	N ₁ ¹ / ₃ PK, ...	1.05	22.91	—	—
15	N ₂ PK, ...	1.11	26.48	59.42	44.79
16	NKP ₁ ¹ / ₃ , ...	1.22	15.37	—	—
17	O, ...	1.10	6.50	37.16	32.80
18	NKP ₂ , ...	1.35	14.17	—	—
19	NPK ₁ ¹ / ₃ , ...	1.22	11.78	—	—
20	NPK ₂ , ...	1.09	13.16	—	—
21	O, ...	1.19	5.39	33.31	29.60

² The lime was added separately the day after the fertilizer.TABLE 17. — *Fertilizer Plots in 1918. Yield, Time consumed in Picking, and Relative Condition of the Berries.*

Plot.	FERTILIZER.	Date picked.	Time con- sumed in Picking (Picker- minutes).	Yields per Square Rod (Bushels).	Date exam- ined.	Percentage of Berries showing Decay.
1	O, ...	Oct. 4	147	2.50	Oct. 14	11.67
2	N, ...	Oct. 5	240	2.65	Oct. 15	14.35
3	P, ...	Oct. 5	252	2.60	Oct. 16	12.94
4	O, ...	Oct. 5	168	2.56	Oct. 17	22.92
5	O, ...	Oct. 5	288	2.42	Oct. 18	17.55
6	NP, ...	Oct. 5	366	2.56	Oct. 17	18.41
7	N, ...	Oct. 5	306	2.38	Oct. 17	27.41
8	P, ...	Oct. 8	210	2.54	Oct. 14	16.81
9	O, ...	Oct. 8	150	2.38	Oct. 14	18.28
10	NP, ...	Oct. 8	238	2.60	Oct. 14	24.89
11	NPL, ...	Oct. 4	378	2.39	Oct. 15	28.36
12	NP, ...	Oct. 4	273	2.48	Oct. 15	26.04
13	O, ...	Oct. 4	162	2.40	Oct. 15	22.77
14	N ₁ ¹ / ₃ P, ...	Oct. 4	245	2.46	Oct. 16	21.41
15	N ₂ P, ...	Oct. 4	287	2.50	Oct. 15	27.35
16	NP ₁ ¹ / ₃ , ...	Oct. 4	252	2.75	Oct. 15	15.66
17	O, ...	Oct. 4	192	2.54	Oct. 15	16.75
18	NP ₂ , ...	Oct. 1	256	2.63	Oct. 18	15.46
19	NP, ...	Oct. 1	232	2.44	Oct. 18	16.32
20	NP, ...	Oct. 1	280	2.77	Oct. 17	17.74
21	O, ...	Oct. 1	200	2.43	Oct. 16	15.01

Column 4 of Table 16 gives the percentages of berries showing decay two weeks after the fruit was picked. Most of this rot was surely present when the berries came from the bog. The fertilizer evidently greatly increased the rotting on the vines. The last column of this table shows that the fertilizer also greatly harmed the keeping quality of the fruit. The berries from only a part of the plots were examined, as this was all that seemed necessary to bring out the facts.

The last column of Table 17 shows the condition of the fruit two weeks after it was picked in 1918. The percentages for some reason fail to tell so marked a story as those of 1917. The figures in the fourth column of this table were obtained by multiplying for each plot the minutes consumed in picking by the number of pickers. They therefore show the relative cost of harvesting the various plots. This expense was much greater with the treated areas than with the checks.

The treated and check areas yielded at about the same rate in 1917, but the checks produced less in 1918.

In both 1917 and 1918 the fertilized plots developed a considerable growth of weeds, especially of fireweed (*Erechtites hieracifolia* Raf.) and beggar-ticks (*Bidens frondosa* L.), not much found elsewhere on the bog.

The fruit of the plot treated with lime decayed more than that of any other plot in both 1917 and 1918, as it had in the three previous years. Table 18 shows the results with two new plots to which slaked lime at the rate of 1 ton per acre was applied on June 13. The berries were of the Early Black variety, and 8 bushels from each plot and each check were examined. On the whole, the fruit from these limed areas rotted more than that from the checks. This result, as far as it goes, accords with that of fertilizer plot 11.

Table 19 gives the yields of the station fertilizer plots by years and the total yields since they were started. Considering all the experience with these plots, it seems that the advantage of any slight increase in yield that may have been caused by the fertilizers has been much more than balanced by the cost of the treatment, the deterioration in the quality of the fruit, the greater cost of picking due to the increased vine growth, and the incursion of weeds.

TABLE 18. — *Effect of Liming the Bog on the Quality of the Fruit.*

PLOTS AND CHECKS.	Area (Square Rods).	Location on Station Bog.	Date picked.	Yields per Square Rod (Bushels).	Date exam- ined.	Percentage of Berries showing Decay.
Lime 1, ...	8.0	Section 1	Sept. 22	2.59	Oct. 21	21.51
Lime 1 (check 1), . . .	8.0	Section 1	Sept. 22	2.59	Oct. 21	17.95
Lime 1 (check 2), . . .	8.0	Section 1	Sept. 22	2.72	Oct. 21	15.02
Lime 2, ...	7.6	Section 21	Sept. 11	2.66	Oct. 22	12.30
Lime 2 (check), . . .	7.5	Section 21	Sept. 11	2.58	Oct. 22	11.92

TABLE 19. — *Effect of Fertilizers on Cranberry Yield.*

Plot.	FERTILIZER. ¹	YIELDS (BUSHELS).									
		1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	Total.	
1	O, ...	10.0	1.9	15.8	9.0	5.8	10.7	9.7	20.0	82.9	
2	N, ...	12.0	3.2	16.5	9.5	6.2	9.3	9.7	21.2	87.6	
3	P, ...	11.0	2.0	15.7	8.8	5.5	9.0	10.2	20.8	83.0	
4	K, ...	11.0	1.7	17.0	8.0	5.5	9.6	10.7	20.5	84.0	
5	O, ...	13.0	1.8	19.3	6.5	7.6	9.2	10.6	19.3	87.3	
6	NP, ...	16.0	3.1	19.2	6.7	7.8	6.3	7.7	20.5	87.3	
7	NK, ...	14.5	3.9	18.8	7.7	8.0	6.6	6.5	19.0	84.9	
8	PK, ...	14.5	2.7	17.8	8.7	8.2	8.0	7.3	20.3	87.5	
9	O, ...	14.0	2.3	17.7	6.5	4.9	9.0	5.5	19.0	78.9	
10	NPK, ...	14.0	4.0	20.0	8.7	7.3	6.9	5.0	20.8	86.7	
11	NPKL, ...	16.0	3.5	17.7	8.2	6.3	2.9	6.7	19.1	80.4	
12	NPKel	15.0	3.4	20.3	7.8	7.2	6.0	8.4	19.8	87.9	
13	O, ...	12.0	2.5	19.2	7.7	5.7	7.7	8.5	19.2	82.4	
14	N _{1½} PK, ...	12.0	4.8	17.7	10.0	6.9	5.5	8.4	19.7	85.0	
15	N ₂ PK, ...	10.0	6.1	9.8	10.4	5.8	4.5	8.9	20.0	75.6	
16	NKP _{1½} , ...	10.0	5.7	18.0	9.0	7.0	7.2	9.7	22.0	88.6	
17	O, ...	10.5	3.2	20.3	9.7	7.0	9.3	8.8	20.3	89.1	
18	NKP ₂ , ...	10.0	5.5	18.0	10.0	6.2	8.3	10.8	21.0	89.9	
19	NPK _{1½} , ...	10.0	4.0	19.1	9.0	6.8	7.8	9.8	19.5	86.0	
20	NPK ₂ , ...	12.5	4.2	20.0	6.8	7.3	9.0	8.8	22.2	90.8	
21	O, ...	11.5	3.0	22.1	10.3	6.1	10.3	9.5	19.4	92.2	
22	O, ...	11.5	3.1	—	10.8	—	—	—	—	—	
23 ^d	O, ...	14.5	2.0	20.0	6.3	—	8.0	4.6	—	—	

¹ The potash salts were omitted in 1918.

WEATHER OBSERVATIONS.

Weather observations and records were made in both 1917 and 1918 as previously, daily reports being telegraphed to the Boston office of the Weather Bureau in the spring and fall, and special frost predictions being telephoned to growers when asked for.

Severe winterkilling occurred in 1916-17 on exposed bogs, the injury being more extensive than in any year since 1906. The damage came much earlier in the winter than usual. Many bogs winter flowed the first days in February and some flooded late in January were badly hurt. The winterkilling seemed a slow process. It probably took several days and perhaps a week or two to complete it, as the weather and bog conditions were so long the same. Unprotected bogs were frozen deeper than

the cranberry roots extended for some time before the killing took place, and the vines were exposed to strong, dry, northerly winds most of the three weeks ending February 5. On some badly injured bogs, areas not picked the fall before showed little harm, and new plantings in which the vines were still in the hills were not hurt, while heavy vines near by that had been picked were badly killed.

From these and other observations the writer ventures to guess that cranberry winterkilling usually is due to a drying out of the vines resulting from a freezing in of the roots that prohibits their taking in moisture to replace that given off by the leaves exposed to strong, dry winds. As the dormant cranberry foliage is hard and tough, it probably parts with its moisture very slowly, even in the most drying weather, and the writer thinks it usually takes several days of such exposure to kill the vines. The escape from injury of new plantings and unpicked vines may have been due to their being less dry before they were exposed to winterkilling conditions than were the picked vines, their roots not having been disturbed.

The spring and early summer of 1917 were late, cold and wet, and as a result the cranberry crop was very tardy in ripening. There was little or no frost injury in the spring, but on the nights of September 10 and 11 hard freezes caught the berries still in a green or slightly colored condition. The minimum bog temperature recorded at the station on the 10th was $24\frac{1}{2}^{\circ}$ F., and on the 11th, 26° F. The first night the wind at the station was from the northeast, with a velocity of 10 miles an hour at 8 P.M., and an average of $3\frac{3}{4}$ miles from midnight to 6 A.M. This wind was very generally, though, as it proved, unwisely, relied on to prevent a hard frost. Temperatures as low as 18° F. were reported from some bogs, severe injury being common except in Barnstable County and on the Vineyard and Nantucket, all of which escaped with little or no hurt. The night of the 11th, however, bogs in Barnstable County suffered much loss.

From growers' reports the writer estimated the Cape cranberry loss for both nights to be 60 per cent. Mr. V. A. Sanders, field agent of the Bureau of Crop Estimates, set the loss in Plymouth County at about 67 per cent, and in Barnstable County at about 37 per cent. This reduction, added to that due to the winterkilling and the rather large fruit-worm injury, left the smallest crop picked on the Cape since 1905, only 118,574 barrels of berries, exclusive of those marketed locally and those canned and evaporated, being shipped from this section.

From observations made on Sept. 2, 1916, and on the night of Sept. 10, 1917, it is certain that cranberries in the greenish white state that immediately precedes the ripening of the fruit will endure a temperature of 26° F. without hurt, and of 25° F. with little injury, but 24° F. seems to harm such fruit greatly if it continues long.

The winter of 1917-18 was the most severe in New England of any on record. The ponds and streams were low in the late fall and early winter,

and so an unusually large percentage of the bogs was exposed to the winter. Winterkilling of the vines was as severe and widespread as in the previous winter, and the attending weather conditions were much the same.

A hard frost occurred the night of June 20, 1918, reducing the prospective crop, as estimated, over half. The lowest temperature recorded at the station was $26\frac{3}{4}^{\circ}$ F., and 23° F. was reported from some bogs. The vines had begun to bloom, and many growers used water more sparingly than they should have on that account. A widespread effect of this frost was noted later in the season. The vines had failed to recover and form buds for the next year on considerable areas. On such areas, therefore, the frost really destroyed two crops.

FROST STUDIES.

As the records made at the station during the past five years seemed a fair basis for a study of frost conditions on cranberry bogs on Cape Cod, and as the great loss from frost in September, 1917, made the need of closer predictions seem imperative, the writer gave most of the following winter to a careful investigation in this connection. The most important result was a new method for computing minimum temperatures on any night in which frost conditions prevail. The method is probably as reliable for computing on windy nights, if they are clear, as on still ones, but much cloudiness during the night renders it inaccurate.

Predictions by the new method are made from readings at 8 P.M., standard time. As a few minutes are needed to take the readings and make the calculation, the forecast is not ready until 8.15. As damaging frost may occur as early as 11 P.M., this warning will sometimes give only three hours in which to flood. Frost flooding can be done on many bogs in this time, but it takes several hours more on most of the larger areas with their present flumes and canals. Many growers would profit by greatly enlarging these equipments so as to flood more quickly and make full use of the warnings obtained by the new method.

The 8 P.M. temperature at a height of from 17 to 20 feet above the bog level is one of the factors used in the new method. Quite accurate predictions have been made for the Atwood bog at South Carver by substituting the shelter temperature at that bog for the station shelter temperature in the formula used in calculating. This suggests that growers may help both themselves and the work by placing Green thermometers in elevated locations near their bogs, and telephoning to the station their 8 P.M. reading.

BLUEBERRY WORK.

On May 14, 1917, thirty-nine swamp blueberry bushes, selected for the quantity and quality of fruit they bore in 1916, were transplanted from the wild to the station blueberry plantation at East Wareham. The writer spent a week in New Jersey in late July and early August, 1917,

studying methods of cranberry and blueberry growing there. He brought back bud wood of two very select blueberry strains (Nos. 620A and 834A of the Bureau of Plant Industry), carrying it on ice in a thermos bottle during the trip home. It was cut from bushes in Miss Elizabeth C. White's plantation at Whitesbog, N. J., on the morning of August 4. Buds from it were inserted on sprouts in the station plantation on dates and in numbers as follows: —

August 8, No. 834A, 12 buds.

August 9, No. 620A, 40 buds.

August 10, No. 620A, 7 buds.

Prof. F. V. Coville's and Miss White's methods were followed in this budding. Only two of the fifty-nine select buds inserted developed into sprouts in 1918. The severe winter probably killed a large percentage of them.

The writer visited Miss White's plantation again in 1918, and brought back more select bud wood, buds from which were inserted in sprouts in the station plantation as follows: —

July 28, No. 834A, 23 buds; No. 1004A, 11 buds.

July 29, No. 1004A, 8 buds; No. 620A, 32 buds.

July 30, No. 620A, 3 buds; No. 823A, 20 buds.

The bud wood was cut from Miss White's bushes on the afternoon of July 25.

BULLETIN No. 193.

DEPARTMENT OF AGRICULTURAL ECONOMICS.

THE SUPPLY AND DISTRIBUTION OF CONNECTICUT VALLEY CIGAR LEAF TOBACCO.

PART I.

HISTORY OF CONNECTICUT VALLEY TOBACCO PRODUCTION AND THE CIGAR INDUSTRY.

The culture of tobacco in the Connecticut valley is almost coeval with its first settlement. It was grown here during the years from 1640 to 1660. The stringent legislation of Connecticut restricted, under severe penalty, the use of tobacco to that grown in the colonies. In 1646 a law was passed prohibiting the use of tobacco by any one under twenty-one years of age, and requiring those who had not already acquired the tobacco habit to present a certificate from a physician before beginning it. A fine of a sixpence was imposed for the use of tobacco in the public streets. These restrictions did not stop the cultivation of tobacco, but tended to increase exportation and diminish home consumption. Nevertheless, until the latter part of the eighteenth century the production of tobacco in New England was of comparatively little importance. During the first quarter of the nineteenth century the manufacture of cigars began as a household industry in some of the towns of the valley. The industry grew very slowly, and correspondingly slow progress was made in the growing of cigar leaf, which likewise was undertaken first in the Connecticut valley, in the section lying between Hartford, Conn., and Springfield, Mass. In no period prior to 1801 did the annual production of tobacco exceed 20,000 pounds.

Over a century ago Connecticut tobacco was recognized as essentially different from the Virginia types, and peculiarly fitted to the manufacture of cigars. In 1801, 20,000 pounds of tobacco were produced in the Connecticut valley, and cigar manufacturing began in a small way. The first

tobacco warehouse was established at Warehouse Point, Conn., in 1825. About 3,200 pounds of tobacco were packed here and shipped to New York. The first factories were established in 1810, one at East Windsor, and another at Suffield, Conn. The cultivation was gradually extended, and in 1840 it was a general crop, though small, grown as regularly as any other in the valley.

It is to Mrs. Prout, the wife of a farmer of South Windsor, Conn., that the men of this country are indebted for the first cigar in America. The Indians had made and smoked a roll of tobacco, but the cigar as we know it to-day had its birth in America in 1801. Wives of other farmers joined Mrs. Prout in her enterprise, and peddled their cigars from village to village in wagons. The "Long Nines" and "Windsor Particulars" soon came to be the principal brands.

Other areas suitable for the production of cigar leaf types of tobacco were exploited at about the same time as the Connecticut valley. The present areas in Lancaster and York counties, Pennsylvania; the Gadsden county area in Florida; the Miami valley area in Ohio; and the Onondaga and Big Flats area in New York are the chief sections. Nowhere, however, did the production of cigar tobacco attain much importance till the decade just preceding the civil war. This fact is very clearly indicated in the table below.

TABLE 1. — *Production of Tobacco in the United States by Localities, 1849 and 1859.*¹

LOCALITIES.	PRODUCTION (POUNDS).	
	1849.	1859.
Connecticut valley: —		
Connecticut, ...	1,267,624	6,000,133
Massachusetts, ...	138,246	3,233,198
Total for Connecticut valley, ...	1,405,870	9,233,331
Pennsylvania, ...	912,651	3,181,586
Ohio (Miami valley), ...	1,200,000	3,900,000
Florida, ...	998,614	828,815
New York, ...	83,189	5,764,582
Total cigar leaf, ...	4,600,324	22,908,314

¹ Compiled from census reports.

The present important Wisconsin area had no commercial importance until after the civil war.

This rapid increase in the production of cigar leaf tobacco from 1850 to 1860 was coincident with a great increase in the use of cigars in this country, which was reflected in our imports of cigars and cigar leaf for the same period. The number

of cigars imported in 1850 was 124,303,000, valued at \$1,469,097; this was increased to 460,404,000 cigars valued at \$4,581,551 in 1860. Imports of unmanufactured tobacco (practically all cigar leaf) likewise increased from 2,480,446 pounds, valued at \$272,438, in 1850, to 6,940,671 pounds, valued at \$1,365,695, in 1860. Most of the leaf was imported from Cuba and Germany. The high-grade cigars came from Cuba, and the lower grades mostly from Germany.¹

Since the Cuban tobacco made an acceptable blending with the domestic leaf, the popularity of the Cuban cigar increased. Connecticut, however, preferred her own leaf, being noted between 1850 and 1860 for her production of "Clear New England" cigars.

It was not until the middle of the century that cigars gained commercial importance. The following table shows the gradual increase in the number manufactured in the United States from 1864, the first entire fiscal year for which returns are reported by the Commissioner of Internal Revenue, to the present time:—

TABLE 2. — *Increase since 1864 in the Number of Cigars manufactured in the United States.*²

FISCAL YEAR.	Number of Large Cigars.	FISCAL YEAR.	Number of Large Cigars.
1864, ...	492,780,700	1910, ...	6,810,098,416
1870, ...	1,139,470,774	1911, ...	7,048,505,033
1880, ...	2,367,803,248	1912, ...	7,044,257,235
1890, ...	4,087,889,983	1913, ...	7,571,507,834
1900, ...	5,565,669,701	1914, ...	7,174,191,944
1907, ...	7,302,029,811	1915, ...	6,599,188,078
1908, ...	6,488,907,269	1916, ...	7,042,127,401
1909, ...	6,667,774,915	1917, ...	7,559,890,349

The first tax on cigars was imposed by act of Congress July 1, 1862, and took effect September 1 of the same year. Licenses for dealers and manufacturers were not required until 1868.

CONNECTICUT VALLEY.

Twelve counties in New England produce one acre or more of tobacco, but only ten — Windham, in Vermont; Cheshire, in New Hampshire; Franklin, Hampden and Hampshire, in Massachusetts; and Hartford, Middlesex, Tolland, Litchfield and Fairfield, in Connecticut — reported more than 10,000 pounds each in 1909. Approximately 94 per cent of the tobacco is raised in the Connecticut River valley proper; the tobacco of Litchfield and Fairfield counties (Connecticut), amounting to about 6 per cent of the total, is grown in the Housatonic valley. Moreover, the quality

¹ Mathewson, Bull. No. 244, Bureau of Plant Industry, p. 18.

² Compiled from reports of Commissioner of Internal Revenue.

of tobacco grown in both valleys is similar and known to the trade as Connecticut valley leaf. Hence it seems best to consider all the tobacco grown in the ten counties as Connecticut valley tobacco, and the entire district as the Connecticut valley.

GROWTH OF THE INDUSTRY.

Tobacco has been grown in the Connecticut valley since about 1640. With the exception of a few bad years the crop has steadily increased since that time. The last fifteen years have seen by far the greatest increase.

TABLE 3. — *Acreage, Production and Value of Cigar Leaf Tobacco since 1859.*

In the United States.

YEAR.	Acreage.	Production (Pounds).	Value.
1859, ...	(1,880)	18,643,832	—
1879, ...	68,975	90,749,997	—
1909, ...	166,240 ¹	195,960,000	\$19,190,000
1916, ...	178,800	223,444,000	36,361,000
1917, ...	189,800	218,627,000	56,079,000
1918, ...	208,800	260,592,000	55,823,000

In the Connecticut Valley.

1859, ...	—	9,264,157	—
1879, ...	12,196	19,716,363	—
1909, ...	21,745	37,961,893	\$5,670,000
1916, ...	31,300	51,285,000	13,522,000
1917, ...	33,000	46,200,000	17,740,000
1918, ...	35,000	52,500,000	22,500,000 ²

TABLE 4. — *Tobacco Production in the United States, 1839-1918 (United States Census).*

	Pounds
1839, ...	219,163,319
1849, ...	199,752,655
1859, ...	434,209,461
1869, ...	262,735,341
1879, ...	472,661,157
1889, ...	488,256,646
1899, ...	868,112,865
1909, ...	1,055,764,806
1918, ³	1,340,019,000

¹ Estimated.

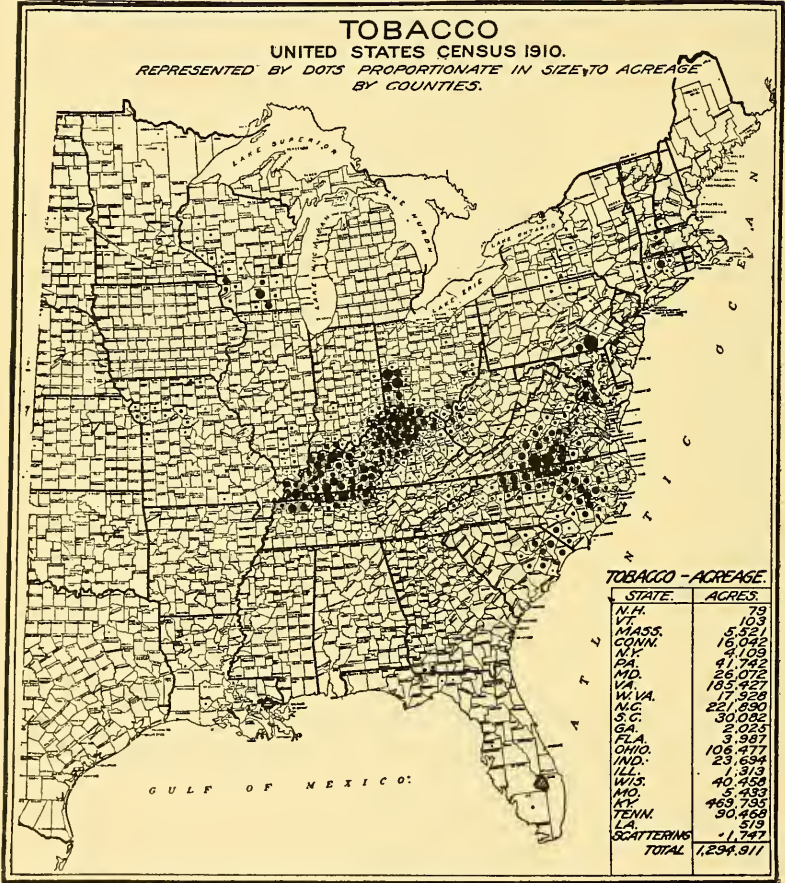
³ Estimate, United States Department of Agriculture.

² Preliminary estimate.

TABLE 5. — *Production of Tobacco in the United States (Pounds).*¹

STATES.	1918.	1917.	1916.	1914.	1899. ²
Kentucky, ...	427,500,000	426,600,000	435,600,000	364,000,000	314,288,000
North Carolina, ...	282,000,000	204,750,000	176,000,000	172,250,000	127,503,000
Virginia, ...	146,300,000	129,500,000	129,200,000	113,750,000	122,885,000
Ohio, ...	113,288,000	99,072,000	95,000,000	78,120,000	65,957,000
Wisconsin, ...	65,170,000	45,885,000	55,753,000	53,808,000	45,500,000
Pennsylvania, ...	64,752,000	58,100,000	49,096,000	47,995,000	41,503,000
Tennessee, ...	62,240,000	81,810,000	81,760,000	63,468,000	49,158,000
South Carolina, ...	62,208,000	51,120,000	20,280,000	36,500,000	19,896,000
Connecticut, ...	37,500,000	29,540,000	36,186,000	35,754,000	16,931,000
Maryland, ...	23,738,000	22,594,000	19,635,000	17,600,000	24,589,000
Indiana, ...	15,159,000	14,060,000	13,764,000	12,150,000	6,882,000
Massachusetts, ...	15,000,000	11,833,000	12,118,000	11,550,000	6,407,000
West Virginia, ...	9,792,000	9,040,000	12,690,000	8,856,000	3,087,000
Florida, ...	4,416,000	3,410,000	3,025,000	4,300,000	1,126,000
New York, ...	3,750,000	3,125,000	4,551,000	5,980,000	13,958,000
Missouri, ...	2,970,000	2,820,000	3,040,000	4,920,000	3,042,000
Georgia, ...	2,668,000	1,600,000	1,534,000	1,900,000	1,106,000
Alabama, ...	700,000	146,000	60,000	140,000	312,000
Illinois, ...	532,000	560,000	525,000	468,000	1,447,000
Arkansas, ...	210,000	210,000	250,000	427,000	832,000
Louisiana, ...	126,000	210,000	90,000	280,000	102,000
New Hampshire, ...	—	167,000	165,000	177,000	182,000
Vermont, ...	—	165,000	160,000	170,000	291,000
Texas, ...	—	134,000	140,000	116,000	550,000
Totals, ...	1,340,019,000	1,196,451,000	1,150,622,000	1,034,679,000	867,534,000

¹ United States Department of Agriculture estimates.² United States Census Report.



MAP 1.

TABLE 6. — *Production of Cigar Leaf Tobacco in the United States (Pounds).*¹

	1918.	1917.	1916.	1915.	1914.	1913.	1912.
New England, ...	52,500,000	46,200,000	51,235,000	38,270,000	47,651,000	38,295,000	39,950,000
New York, ...	3,750,000	3,125,000	4,551,000	5,280,000	5,980,000	4,386,000	5,200,000
Pennsylvania, ...	64,752,000	58,100,000	49,096,000	42,390,000	47,995,000	46,680,000	64,090,000
Ohio, Miami valley, ...	67,326,000	61,602,000	58,200,000	54,270,000	54,144,000	37,449,000	53,460,000
Wisconsin, ...	65,170,000	45,885,000	55,753,000	36,900,000	53,805,000	50,740,000	54,438,000
Georgia and Florida, ...	7,084,000	5,010,000	4,559,000	5,045,000	6,200,000	5,800,000	3,766,000
Totals, ...	260,582,000	220,017,000	223,444,000	182,155,000	215,778,000	183,350,000	220,904,000

TABLE 7. — *Production of Tobacco in the Connecticut Valley (Pounds).*¹

	1918.	1917.	1916.	1915.	1914.	1909.	1899. ²	1879.	1869.	1859.	1849.	1839.
Massachusetts, ...	15,000,000	11,833,000	12,118,000	8,030,000	11,550,000	9,549,000	6,407,000	5,369,000	7,313,000	3,233,000	138,000	65,000
Connecticut, ...	37,500,000	29,540,000	36,186,000	29,070,000	35,754,000	28,110,000	16,931,000	14,045,000	8,329,000	6,000,000	1,268,000	472,000
New Hampshire, ...	-	167,000	165,000	140,000	177,000	137,000	182,000	171,000	155,000	19,000	-	-
Vermont, ...	-	165,000	160,000	130,000	170,000	165,000	291,000	131,000	73,000	12,000	-	1,000
Totals, ...	52,500,000	41,705,000	48,629,000	38,270,000	47,651,000	37,961,000	23,811,000	19,716,000	15,870,000	9,264,000	1,406,000	538,000

¹ Crop estimates, United States Department of Agriculture.² United States Census.

TABLE 8. — *Production of Tobacco in Massachusetts (Pounds).*¹

COUNTIES.		1865.	1875.	1885.	1895.	1905.	1909. ²
Barnstable,	.	360	—	—	—	—	73
Berkshire,	.	198,800	99,609	229,462	34,531	104	—
Bristol,	.	2,420	530	—	—	—	110
Dukes,	.	800	—	—	—	—	—
Essex,	.	4,850	1,000	—	—	—	105
Franklin,	.	3,143,799	1,997,091	1,174,845	1,829,421	2,718,979	2,659,969
Hampden,	.	1,569,463	1,224,670	912,112	987,379	2,215,035	1,852,773
Hampshire,	.	4,394,925	2,655,561	1,893,006	2,665,765	4,626,675	5,035,454
Middlesex,	.	3,405	240	—	—	—	320
Norfolk,	.	775	—	—	—	—	—
Plymouth,	.	1,646	70	28	—	—	35
Worcester,	.	40,218	14,885	1,450	—	10	467
Totals,	.	9,361,461	5,993,666	4,210,903	5,017,096	9,561,453	9,549,306

¹ Massachusetts State Census Reports.² United States Census Reports.

TABLE 9. — *Production of Tobacco in Connecticut.*¹

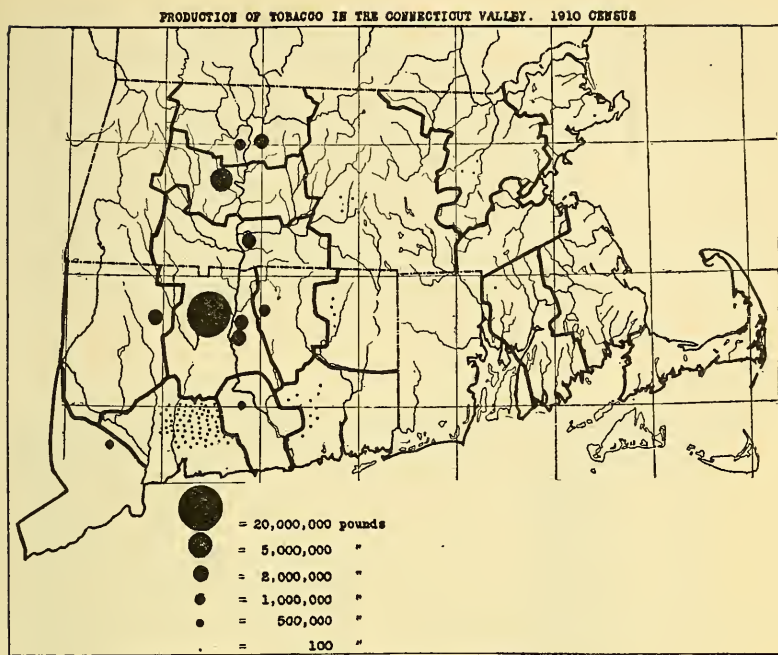
COUNTIES.			1859.		1879.		1889.		1899.		1909.	
			Acres.	Production.	Acres.	Production.	Acres.	Production.	Acres.	Production.	Acres.	Production.
Fairfield,	.	.	—	61,975	808	973,933	375	426,093	399	584,640	253	412,065
Hartford,	.	.	—	4,221,474	5,112	9,039,514	4,606	6,598,517	8,007	13,577,860	13,774	24,365,134
Litchfield,	.	.	—	736,185	1,586	2,211,151	1,011	1,376,472	1,138	1,817,260	1,144	1,897,205
Middlesex,	.	.	—	433,245	573	906,753	144	198,587	228	333,050	308	504,330
New Haven,	.	.	—	153,453	167	215,195	40	41,350	18	18,410	4	7,356
New London,	.	.	—	325	19	29,622	—	—	3	4,000	2	1,030
Tolland,	.	.	—	393,476	405	666,634	155	233,905	326	595,510	557	922,873
Windham,	.	.	—	—	2	1,850	—	—	—	40	—	430
Totals,	.	.	—	6,000,133	8,672	14,044,652	6,331	8,874,924	10,119	16,930,770	16,042	28,110,453

¹ United States Census Reports.

The cigar type industry of New England is confined principally to the Connecticut and Housatonic valleys, extending through Connecticut and Massachusetts into the southern counties of New Hampshire and Vermont. Hartford County, Connecticut, produces 64.7 per cent of the New England total, and six counties, Hartford, Litchfield and Tolland in Connecticut, and Hampshire, Franklin and Hampden in Massachusetts, produce approximately 97.5 per cent.

TABLE 10.—*Tobacco Growers and Acreage in Massachusetts in 1916.*

	Number of Growers.	NUMBER OF ACRES.				
		Havana Seed.	Broad- leaf.	Primed.	Shade.	Total.
<i>Hampshire County.</i>						
Amherst, ...	43	246	—	—	—	246
Easthampton, ...	23	122	—	—	—	122
Hadley, ...	193	1,605	126	—	33	1,764
Hatfield, ...	174	1,753	—	35	70	1,858
Northampton, ...	37	162	—	—	40	202
Pelham, ...	1	6	—	—	—	6
Southampton, ...	25	103	—	—	—	103
Williamsburg, ...	8	13	—	—	—	13
Totals;	504	4,010	126	35	143	4,314
<i>Hampden County.</i>						
Agawam, ...	79	616	16	108	225	965
Chicopee, ...	2	35	—	—	101	136
East Longmeadow, ...	5	10	—	—	—	10
Granville, ...	10	33	—	—	—	33
Longmeadow, ...	2	15	—	—	1	16
Southwick, ...	93	671	3	41	210	925
Springfield, ...	2	2	—	—	—	2
Westfield, ...	36	264	57	110	—	431
Totals, ...	229	1,646	76	259	537	2,518
<i>Franklin County.</i>						
Ashfield, ...	2	—	7	—	—	7
Buckland, ...	1	—	1	—	—	1
Conway, ...	21	55	15	—	—	70
Deerfield, ...	91	606	—	—	62	668
Greenfield, ...	2	17	—	—	—	17
Leverett, ...	6	29	—	—	—	29
Montague, ...	20	81	—	—	—	81
Northfield, ...	17	42	—	—	—	42
Sunderland, ...	66	433	—	20	83	536
Whately, ...	102	707	—	—	130	837
Totals, ...	328	1,970	23	20	275	2,268
Grand totals, ...	1,610	7,626	225	314	955	9,120



The preceding tables show the rapid increase in production of tobacco in the Connecticut valley up to 1914. Because of the unfavorable season of 1915 the production that year was less than normal. Since 1915 the production has slightly increased.

The acreage in 1917 may be divided as follows: broadleaf, 7,200 acres; Havana seed, 16,446 acres; and shade-grown, 5,854 acres. The tobacco acreage in 1917 was probably affected by the large acreage of onions, the growing of this crop being stimulated by the high prices of the previous year. The labor shortage and the war-time demand for a larger production of food crops may also have influenced the tobacco acreage. The shade-grown industry, however, steadily increased, as evidenced by Table 13 on page 161. While the Connecticut State Council of Defense endeavored to check any material increase in tobacco acreage in that state, and to encourage the production of more food products, the Federal government did not discourage the production of tobacco during the period of the war. The United States production during 1918 amounted to 1,340,019,000 pounds; in New England the acreage was 35,000, and the approximate yield 52,500,000 pounds.

DISTRIBUTION OF ACREAGE.

Figure 1 shows the mode or most common acreage to be between 2 and 5 acres per farm. There were 77 farms in Hampden County, Massachu-

setts, in 1916; Hampshire County had 161 and Franklin County 143, having from 2 to 5 acres, making a total of 381 farms. The next most common acreage is from 5 to 8 acres. Hampden County had 41 farms, Hampshire County 132 farms, and Franklin County 65 farms reporting this acreage, with a total for the three counties of 238 farms. There were 163 farms in the three counties that reported from 8 to 11 acres, 80 that reported from 11 to 15 acres, 65 that reported from 15 to 20 acres, 80 that reported 20 or more acres, and 53 farms that reported under 2 acres. The mode, then, is between 2 and 5 acres, but the average per farm in the three counties is 8.4 acres, distributed as follows: Franklin County, 7 acres; Hampshire County, 8.6 acres; and Hampden County, 11 acres.

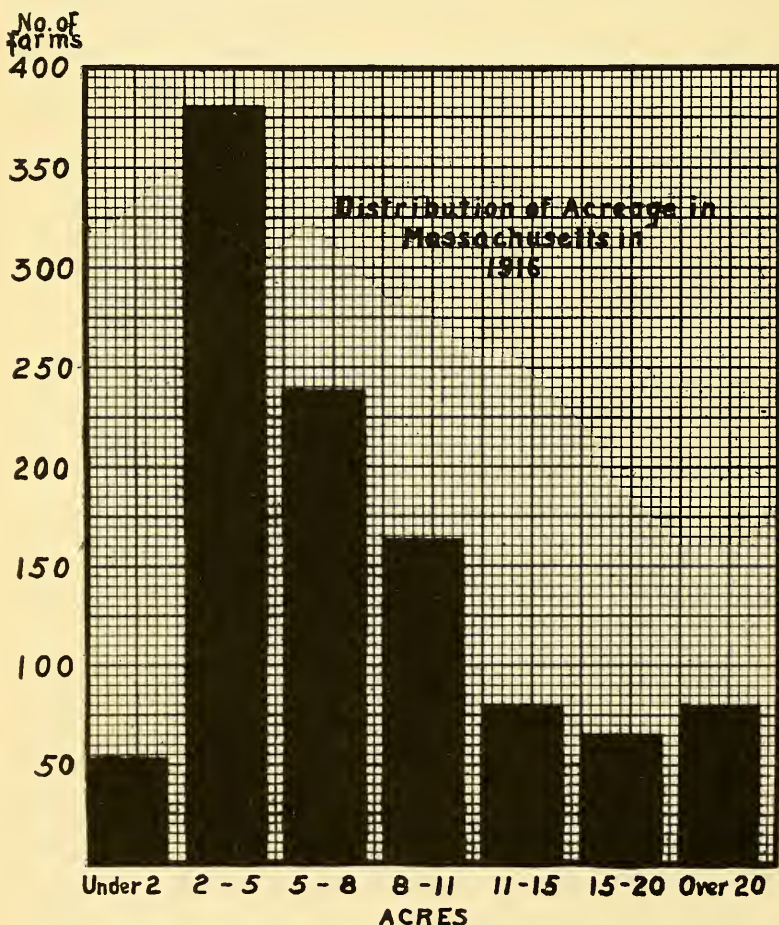


FIG. 1. — Number of farmers with specified acreages of tobacco. Note that of the 1,060 farms depicted, nearly 60 per cent have between 2 and 8 acres per farm, and approximately 40 per cent have each 5 acres or less.

The distribution of acreage according to counties and towns within the counties is given in the following table:—

TABLE 11.— *Distribution of Acreage of Tobacco according to Counties and Towns in Massachusetts.*

Franklin County.

LOCATION.	Average Acres per Farm.	LOCATION.	Average Acres per Farm.
Ashfield, ...	3.2	Montague, ...	4.0
Buckland, ...	1.0	Northfield, ...	2.5
Conway, ...	3.3	Sunderland, ...	8.1
Deerfield, ...	7.3	Whately, ...	8.2
Greenfield, ...	8.2	Average, ...	7.0
Leverett, ...	4.8		

Hampshire County.

Amherst, ...	5.7	Pelham, ...	5.5
Easthampton, ...	5.3	Southampton, ...	4.1
Hadley, ...	9.1	Williamsburg, ...	1.6
Hatfield, ...	10.7	Average, ...	8.6
Northampton, ...	5.5		

Hampden County.

Agawam, ...	12.2	Southwick, ...	9.9
Chicopee, ...	68.0	Springfield, ...	1.0
East Longmeadow, ...	1.9	Westfield, ...	12.0
Granville, ...	3.3	Average, ...	11.0
Longmeadow, ...	8.0		

The comparatively large acreage in Chicopee is due to the inclusion of large shade-grown plantations. To a lesser extent this is true of Southwick and Agawam, but the land in these sections is generally level and the soil favorable to the production of tobacco. Consequently the acreage per farm is larger.

TYPES OF CIGAR LEAF TOBACCO.

Tobacco-growing in the United States is a highly specialized industry. Certain well-defined areas produce tobacco of such quality and texture as to make it desirable for some special manufacturing or export trade.

The following is a rough classification of the varieties and types of tobacco listed by the cigar leaf districts of America in which they are produced:—

TABLE 12. — *Varieties, Location and Types of Tobacco in the Cigar Leaf Districts.*

VARIETIES.	Where grown.	Types or Uses.	Length in Inches.
Zimmer Spanish, . . .	Ohio, ...	Fillers, ...	9-18
Little Dutch, ...	Ohio, ...	Fillers, ...	12-21
Ohio seed leaf, ...	Ohio, ...	Wrappers and binders, .	16-26
Wisconsin binder, . . .	Wisconsin, ...	Binders, ...	14-24
Pennsylvania broadleaf, .	Pennsylvania, . . .	Binders and fillers, . .	14-26
Connecticut broadleaf, .	Connecticut valley, .	Wrappers, ...	14-28
Connecticut Havana seed, .	Connecticut valley, .	Wrappers, ...	14-28
Connecticut shade-grown, .	Connecticut valley, .	Wrappers, ...	12-20
York State Havana, . . .	New York, ...	Wrappers, ...	14-26
Florida shade-grown, . . .	Florida, ...	Wrappers, ...	12-18
Georgia shade-grown, . . .	Georgia, ...	Wrappers, ...	12-18

Such districts are peculiarly adapted to the growing of tobacco for commercial purposes because of distinctive climatic and soil conditions which have much to do with the quality of the leaf.

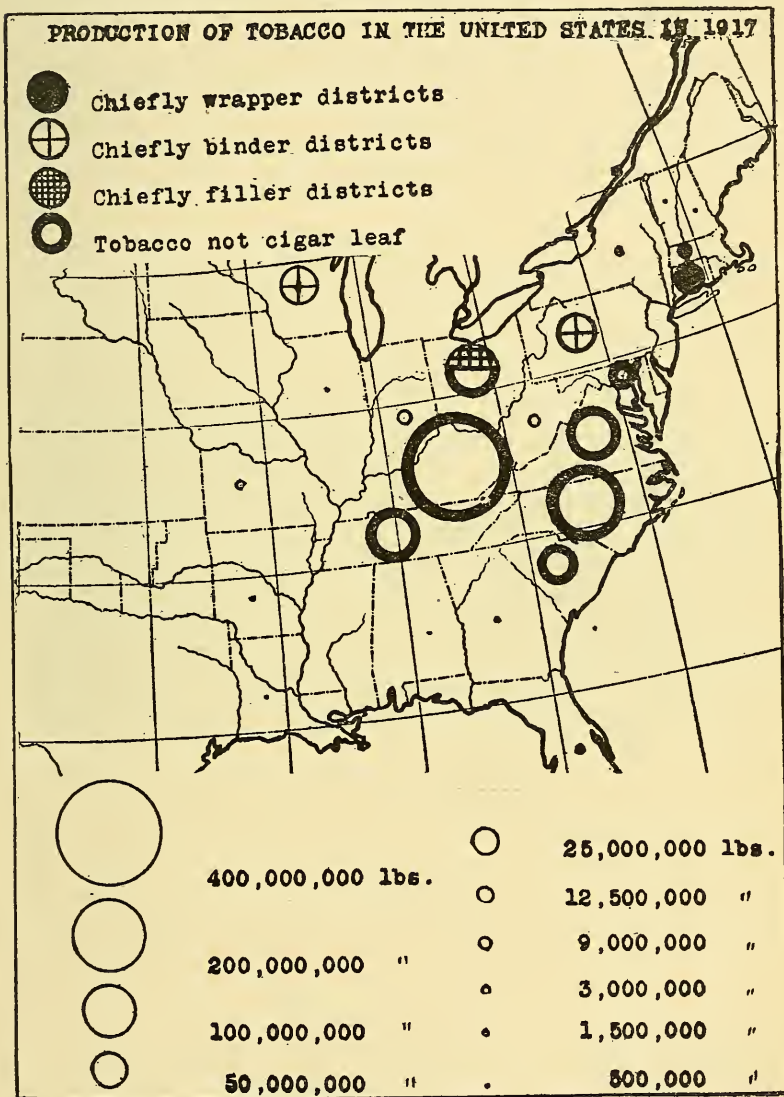
According to the United States Department of Agriculture, tobacco districts are classified as producers of either the cigar type or the chewing, smoking, snuff and export types. It is with the cigar type grown in the Connecticut valley that we are here concerned.

Tobacco of the cigar type may be still further classified into wrappers, binders and fillers, all three classes being necessary in making a cigar. The wrapper, as its name implies, is the outer covering of the cigar. Only comparatively large leaves of special color, texture, aroma and burning qualities can be used for cigar wrappers. A very few wrappers are produced in Pennsylvania and Wisconsin, but the principal competing areas are in Florida, Cuba and Sumatra. Approximately 55 per cent of the cigar wrappers used in America are grown in the Connecticut valley district, and only 29 per cent elsewhere in the United States; the remainder are imported.

Binders is the name given to the tobacco used in making the body of the cigar just under the wrapper. This also requires certain specific qualities found only in tobacco grown in a few limited areas. Wisconsin produces most of the binders, but Pennsylvania, New York, the Connecticut valley and a few other places provide some tobacco of this quality.

The filler is the center or core of the cigar. Small or broken leaves, seconds and otherwise unusable leaves may be used for fillers. Ohio

produces much filler, but the wrapper and binder districts contribute their seconds, broken leaves and other inferior tobacco for fillers. In cheap cigars the filler is composed of a very poor grade of tobacco.



MAP 3.

Generally speaking, wrappers command the highest price, binders the next and fillers the lowest of cigar making tobacco. The Connecticut valley produces all three varieties, but Connecticut valley tobacco is of the

wrapper type so far as the trade is concerned, since 60 per cent of the crop is used for wrappers. For a similar reason Wisconsin is known as the binder-producing district. Nevertheless, there is considerable overlapping, and Wisconsin, New York and Pennsylvania all produce a certain amount of wrappers, varying somewhat from year to year.

Several factors determine whether the leaf will be used as wrapper, filler or binder, such as the length of leaf, aroma, toughness and the condition of leaf, *i.e.*, whether damaged by hail or wind. Under normal conditions a light sandy loam produces a light wrapper leaf. The coarser leaf is used for binders, and the broken, frost-bitten, short and worm-eaten leaves for fillers.

TOBACCO SOILS.

Tobacco may be grown on a great variety of soils, but the climatic conditions, texture and physical properties of the soil determine the distribution of the different classes and types. Climatic conditions control, of course, the general distribution, but the influence of the texture of the soil in modifying the effect of these climatic conditions determines the local distribution of types. Tobacco readily adapts itself to a wide range of climatic conditions, as is seen in the distribution of the plant in our country from Florida to Wisconsin. While it adapts itself very readily to the different conditions of temperature and rainfall which normally prevail during the growing season throughout this wide range of territory, seasons which are either too wet or too dry very often reduce the yield per acre and impair the quality of the product. The plant is, furthermore, peculiarly sensitive to the conditions of moisture and heat.

The best soils for the different types of tobacco in the United States range from the light, sandy lands for the fine bright wrappers of the Connecticut valley, to the heavy clay soils of the limestone areas of the South for the heavier grades of tobacco.

The influence of soil upon the quality of the leaf grown in the Connecticut valley is very marked. Where the soil is a heavy clay loam or is normally very moist, a thick leaf is produced which has considerable oil and gum in its tissues. It cures a dark color, and will bear sweating well, but it is not suitable for cigar wrappers. Upon light, sandy soils, the quality is very fine, the texture of the leaf is thin and the color is light. It is this type of tobacco which is at present in demand for cigar wrappers.

VARIETIES OF TOBACCO.

The Connecticut valley produces three varieties of wrapper leaf, — the broadleaf, the Havana seed leaf and shade-grown. This area is classed as a wrapper and binder section. The tobacco is produced mainly in the open, without shade, under intensive methods of cultivation, fertilization and handling. The highest quality leaf makes acceptable wrappers for cigars, and the remainder is principally used for binder purposes. Since 1901 a considerable acreage of shade-grown tobacco has been cultivated in the Connecticut valley each year.



FIG. 2. — A part of the Connecticut valley as seen from Mount Sugarloaf, South Deerfield, Mass. The "meadows" are dotted with tobacco barns; the soil is very fertile and well adapted to the production of wrapper tobacco.

Sun-grown Tobacco.

Broadleaf. — The broadleaf variety has a broad, silky leaf, very elastic and possessing a rich grain and color two-thirds of its length from the top. Small veins are also characteristic of the leaf. There is only one principal area in the Connecticut valley adapted to the growth of this variety, — a small tract on the east side of the river between Hartford and Springfield.

Havana Seed. — The leaf of the Havana seed is smaller and narrower than the broadleaf. It is exceedingly thin and silky, but possesses less elasticity and covering quality; it does not have the rich grain of the broadleaf, and the middle and lower parts are glossy with large veins, rendering this portion of the leaf undesirable for wrapper purposes. However, the larger part of the leaf can be used for wrappers. The Havana seed yields more wrappers to the acre than does the broadleaf. The Havana seed variety of the New England area is grown almost entirely on the west side of the Connecticut River.

The heavier and slightly damaged or unevenly colored leaves of both the Havana seed and the broadleaf varieties are used for binders. Both varieties are principally air-cured, packed in cases weighing about 300 pounds, and either force-sweated for ninety days, or left to ferment by the natural process during the spring and summer months.

Growing Sun Tobacco.

The Seed Bed. — Both for shade-grown and sun-grown tobacco the young plants are developed from seed in a cold frame or hotbed until they have reached a size suitable for transplanting. The beds are sown from the middle of March to the middle of April. In cold frames from six to eight weeks are required to produce plants of sufficient size for transplanting, and in hotbeds four to six weeks are required. If cloth instead of glass is used to cover the seed beds, eight to ten weeks are required before the plants are large enough to transplant. The usual custom is to transplant them when they have reached a height of 5 to 6 inches.

Transplanting and Cultivating. — The plants are set in rows 3 feet 3 inches to 3 feet 6 inches apart, and from 14 to 20 inches apart in the rows. A machine for transplanting has largely taken the place of the old hand method. When the plants are transplanted with a machine, the distance between plants and the application of water is automatically regulated.

Cultivation begins about a week after setting, and is continued until the plants become too large to permit of cultivation. Ordinary surface cultivation to maintain a loose, fine mulch about the plant is essential, with frequent hoeing to keep down weeds.

Topping and Suckering. — When the seed buds of the plants appear the plant is "topped." In a week or ten days after topping suckers will appear, starting from the base of the three or four top leaves. These are picked off, or, as the tobacco farmer says, the plant is "top suckered." Later the leaves farther down the stalk begin to throw out suckers, and

these in turn must be picked off. When the bottom suckers are removed the plant is usually ready to harvest. Ordinarily the plant is allowed to "ripen," a condition which is further indicated by the slightly wilted appearance of the bottom leaves. Light green blotches also appear on the top leaves. If cut too green the leaf becomes dark colored and will not command the best price.

Shade-grown Tobacco.

The year 1900 marks the real beginning of the "tobacco grown under cloth" industry in the Connecticut valley. It was begun as an experiment in the production of Sumatra wrappers. Imported Sumatra seed was sown, but it was soon found that real Sumatra could not be grown successfully in the Connecticut valley. Cuban Havana, having a little heavier leaf, was tried next; it grew well in its new surroundings. Through careful seed selection it approached more nearly the ideal leaf. An acclimated strain of Cuban seed is now used exclusively for "tent grown" tobacco.

SHADE-GROWN TOBACCO ACREAGE IN THE CONNECTICUT VALLEY

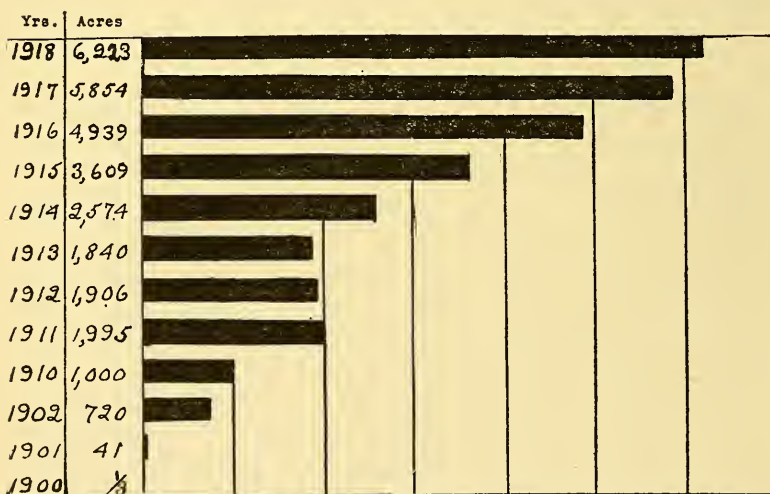


FIG. 3. — Production of shade-grown tobacco. Notice the rapid and remarkably uniform increase in acreage since 1913.

History. — The early history of the industry was marked by varied successes and failures. One grower, for example, a pioneer in the shade-grown venture, sold his first crop for \$1.62 a pound, while his second crop yielded him 50 cents a pound. As a result he went back to sun-grown tobacco entirely. Another grower began in 1902, but raised no-shade-grown in 1904 and 1905. He tried the industry again in 1906, and has



FIG. 4.—125 acres of tobacco under cloth, South Deerfield, Mass.

been very successful since that time. As in the marketing of all specialties the chief difficulty at first was the lack of dependable markets. Manufacturers were afraid to substitute shade-grown for the well-known Sumatra wrapper in their better grades of cigars. To-day this is entirely changed. Connecticut valley growers are not able to raise sufficient shade-grown wrappers to supply the market. We import yearly about 30,000 bales of Sumatra and Java tobacco for wrapper purposes.

From its small beginning the shade-grown tobacco industry has had a remarkable growth, as is shown in the following table. The future looks promising for an extended and increased growth of this particular kind of tobacco. Capital is available for future development and extension, and the owners of choice tobacco land have numerous opportunities to lease it to firms desirous of increasing the acreage under cloth.

TABLE 13. — *Production of Shade-grown Tobacco in the Connecticut Valley.*

YEAR.	Acres.	Bales. ¹
1900, ...	—	2
1901, ...	41	240
1902, ...	720	4,320
1916, ...	1,000	6,000
1911, ...	1,995	11,970
1912, ...	1,906	11,436
1913, ...	1,840	11,040
1914, ...	2,574	15,444
1915, ...	3,609	20,454
1916, ...	4,939	29,634
1917, ...	5,854	35,124
1918, ...	6,223	—

¹ A bale contains 150 to 175 pounds.

TABLE 14. — *Acreage of Shade-grown Tobacco in the Connecticut Valley, 1915-18.*

	Grower.	1915.	1916.	1917.	1918.
<i>Connecticut.</i>					
Tariffville District, ...	1	254	240	252	—
	2	30	40	40	40
	3	50	35	50	50
	4	8	20	29	21
	5	42	45	46	48
	6	27	30	30	60
	7	—	30	30	—
	8	26	45	50	50
	9	—	—	—	7
	10	—	—	—	252
	—	437	485	527	528

TABLE 14. — *Acreage of Shade-grown Tobacco in the Connecticut Valley, 1915-18 — Continued.*

	Grower.	1915.	1916.	1917.	1918.
<i>Connecticut — Con.</i>					
Avon-Simsbury District, . . .	11	40	35	40	27
	12	16	26	31	32
	13	150	195	196	196
	14	14	—	—	—
	15	—	84	94	57
	16	30	38	38	38
Congamond Pond District, . . .	—	250	378	399	350
	17	—	—	—	13
	18	—	62	87	105
	19	125	165	185	185
	20	178	200	206	206
	21	30	36	40	40
Suffield District, ...	22	26	26	26	26
	—	359	489	544	575
	23	50	50	50	75
	24	—	17	17	18
	25	—	20	24	—
	26	—	—	—	24
Windsor Locks District, ...	—	50	87	91	117
	27	150	200	200	213
Poquonock District, ...	28	60	73	74	75
	29	60	80	90	72
	30	25	25	35	35
	31	25	40	45	40
	32	22	22	12	13
	33	15	15	50	60
	34	—	25	25	32
	35	5	8	20	21
	36	—	20	20	25
	37	62	68	68	68
	38	214	254	256	—
	39	—	—	—	237
	40	—	—	16	16.5
	41	—	11	16	20
	42	15	38	41	50
	43	—	—	—	10
	44	—	—	—	30
	45	—	—	—	10
	46	—	—	—	10
	47	—	—	—	10
	48	—	—	—	22
Griffin District, ...	—	503	679	768	856.5
	49	—	—	—	230
	50	210	285	350	—
	51	50	45	49	49
	52	125	108	75	—
	53	160	157	175	260
East Hartford-Manchester-East Windsor District, ...	—	545	595	649	539
	54	—	—	80	112
	55	115	115	118	—
	56	—	108	108	108
	56	—	—	—	118
	57	250	265	265	265
	58	55	75	80	75
	59	29	29	46	46
	60	—	25	40	42
	61	220	249	325	350
	62	—	39	39	39
	63	16	55	60	60

TABLE 14. — *Acreage of Shade-grown Tobacco in the Connecticut Valley, 1915-18 — Concluded.*

	Grower.	1915.	1916.	1917.	1918.
<i>Connecticut — Con.</i>					
East Hartford-Manchester-East Windsor District — <i>Con.</i>	64	—	—	—	25
	65	—	—	50	60
	66	20	20	20	20
	67	—	—	30	—
	68	—	12	12	—
	69	—	—	52	62
	70	—	—	—	32
	71	—	—	—	100
	—	705	992	1,325	1,514
Hazardville District, . . .	72	—	—	20	20.5
	73	—	43	65	—
	74	—	35	42	59
	75	40	40	62.5	62.5
	76	60	70	105	110
	77	38	52	52	—
	78	—	—	13.5	32
	79	20	25	65	—
	80	—	—	—	185
	81	—	—	—	30
	82	—	—	—	47.5
	—	158	265	425	546.5
<i>Massachusetts.</i>					
Hampden District, . . .	83	—	—	14	12.5
	84	1	1	—	—
	85	223	200	230	130
	86	60	60	64	64
	87	—	101	120	120
	88	—	—	59	60
	89	—	—	—	28
	90	—	—	—	20
	—	284	362	487	434.5
Hatfield District, . . .	91	—	35	35	50
	92	—	10	10	12
	93	33	33	33	33
	94	34	68	68	60
	95	—	—	—	32
	96	—	—	—	47
	97	—	—	—	35
	98	—	—	—	16
	—	67	146	146	285
Sunderland District, . . .	99	—	35	35	—
	100	11	9	11	—
	101	—	70	70	60
	102	90	112	112	112
	103	—	35	65	65
	104	—	—	—	28
	—	101	261	293	265
Totals, ...	—	3,609	4,939	5,854	6,223.5

The above table indicates that the shade-grown tobacco is confined to the following districts: Tariffville, Avon-Simsbury, Congamond Pond, Suffield, Windsor Locks, Poquonock, Griffin, East Hartford-Manchester-East Windsor, Hazardville, in Connecticut; and the Hampden, Hatfield and Sunderland districts in Massachusetts.

A peculiarity of the industry is the relatively large acreage per grower. Table 15 shows the number of farms, the number of growers and the number of growers operating two or more farms, with the average acreage in each case. It will be seen that the average acreage per grower increased during the first three of the years indicated, falling again in 1918. The decline in this year was due in part to the appearance of 20 new producers of shade-grown tobacco, whose average acreage was but 35.2 acres. Without these the average acreage would have shown an increase greater than that of the previous years.

TABLE 15. — *Average Acreage per Farm and per Grower.*

	1915.	1916.	1917.	1918.
Number of acres, ...	3,609	4,939	5,854	6,223
Number of farms, ...	49	69	76	88
Average acreage, ...	73.6	71.58	77	70.7
Number of growers, ...	46	60	67	77
Average acreage, ...	78.4	82.3	87.37	80.8
Growers operating two or more farms, .	3	4	4	3
Average acreage, ...	388.67	430	481.75	562.33

There seems to be a tendency toward concentration of the shade-grown industry in the hands of one large company operator, the proportion of the total area controlled by this company ranging from 14.3 per cent in 1915 to 21.7 per cent in 1918.

TABLE 16. — *Farms classified by Acreage of Shade-grown Tobacco, 1915-18.*

ACRES.	1915.	1916.	1917.	1918.
10 acres or less, ...	3	4	1	5
11 to 20 acres, ...	8	7	13	10
21 to 50 acres, ...	19	29	29	36
51 to 100 acres, ...	7	12	19	19
101 to 150 acres, ...	5	5	5	8
151 to 200 acres, ...	2	6	4	3
201 to 250 acres, ...	5	2	2	4
251 and over acres, ...	1	3	5	4

Several things militate against the small grower, such as the high initial expense and the cost of production. The syndicates have the capital to tide them over the "off year," which frequently occurs in the tobacco busi-

ness. However, some small growers are very successful. They begin by changing from ordinary sungrown to primed Havana, and gradually work up to shade-grown tobacco.

Preparation and Cultivation. — To prepare for producing shade tobacco the entire field is set with posts 9 feet high and about 33 feet apart each way. Heavy wire is stretched from one post to another. This framework is then covered with a specially woven fabric similar to cheesecloth.

The plants, transplanted from the seed beds to the fields from May 15 to June 15, are set in rows 3 feet apart, and from 15 to 20 inches apart in the row, then the sides of the tent frame are covered, the cloth reaching to the ground.

The growing plants are well cultivated in order to keep the soil loose and free from weeds. With good soil and thorough cultivation the plants reach a height of nine feet, and bear from 15 to 20 good sound leaves. The plants of shade-grown tobacco are neither topped nor suckered, enabling the plant to produce more and thinner leaves, the quality so much desired in wrappers.

Harvesting. — Harvesting usually begins about July 20, as soon as the leaves begin to ripen. All the leaves are picked by hand, four or five pickings being made at intervals of from seven to ten days. The harvest begins with the bottom leaves, from four to six leaves being removed each time. The best leaves are generally found in the second picking. As the leaves are gathered they are put in baskets which are placed on low trucks and hauled outside the tent. The baskets are transferred to flat wagon beds and taken to the curing sheds. Sometimes small boys do this work, while the older and more experienced laborers are used in priming the tobacco.

At the curing sheds the leaves are strung on strings attached to laths. This work is usually done by women and children. The leaves are put face to face in pairs, twenty pairs on a lath. Stringers are paid (1917) about 45 cents per bundle of 50 laths. Experienced women and girls can easily earn from \$2 to \$3.50 per day.

The laths thus strung are hung in the curing sheds where they remain from three to five weeks. The up-to-date curing sheds may be ventilated by side openings made by placing every third or fourth board on hinges, and by ventilators placed at intervals of 10 feet along the ridge of the roof. During damp or cold weather charcoal fires are built. The use of charcoal fires has been the means of saving thousands of dollars' worth of tobacco annually.

YIELDS PER ACRE.

Aside from the question of the cost of producing tobacco, which has been tremendous in recent years, there is the important question of the yield per acre, which largely determines the profit. It costs almost as much to produce a 1,300-pound crop of tobacco as it does to produce a crop of 1,700 pounds, but the money value and the profit per acre are much less.

Farmers in the Connecticut valley have been disturbed in recent

years by the gradual decline in the yield of tobacco. The table below shows this decline, not steady from year to year, but an actual decline. The average yield for the five-year period from 1905 to 1909 was 1,675 pounds in Massachusetts and 1,660 in Connecticut; from 1910 to 1914 it was 1,676 in Massachusetts and 1,675 in Connecticut; while for the four years succeeding, the average was 1,382 pounds in Massachusetts and 1,445 in Connecticut. The average for the whole period, however, was 1,592 for Massachusetts and 1,604 for Connecticut, both still well above the average for the period from 1870 to 1910. Of course the decrease from 1913 to 1918 is largely due to the poor growing season of 1915, to the wind storms of 1916 and 1917, and to the excessive hail and the late frost of 1917.

TABLE 17. — *Yields per Acre (Pounds).*¹

YEAR.	Massachusetts.	Connecticut.
1880, ...	1,599	1,621
1890, ...	1,389	1,402
1900, ...	1,674	1,673
1905, ...	1,850	1,725
1906, ...	1,750	1,735
1907, ...	1,525	1,510
1908, ...	1,650	1,680
1909, ...	1,600	1,650
1910, ...	1,730	1,730
1911, ...	1,650	1,625
1912, ...	1,700	1,700
1913, ...	1,550	1,550
1914, ...	1,750	1,770
1915, ...	1,100	1,350
1916, ²	1,500	1,500
1917, ²	1,430	1,430
1918, ...	1,500	1,500

¹ Figures from United States Department of Agriculture, Bureau of Crop Estimates.

² 1916 and 1917 are revised estimates made by the Massachusetts Agricultural College and tobacco packers.

This decrease has been attributed to many causes, such as a hurtful accumulation of saline matters soluble in water, nitrates, sulfates and chlorides of potash, soda, lime and magnesia, in the surface soil; or an alkaline condition of the soil, resulting from the use of tobacco ash elements, cotton hull ash or carbonate of potash. However, the experiment stations have questioned the truth of these two assumptions. Some attribute the short crop of the last few years to the unnoticed prevalence of root rot in

the field; others attribute it to bad weather, hail, wind storms, frost, etc. Tobacco depends almost entirely upon a sufficient amount of rain and warm weather. The seasons of the last few years have not been favorable to a good growth of tobacco. Actually, the low yield of 1915 is the great cause of the low average.

Figure 5 presents in graphic form the history of the average yield in Massachusetts from 1900 to 1918. Of the Connecticut valley sun-grown crop in 1917 it is estimated that only 60 per cent was not injured by hail, wind or frost, while the loss in shade-grown tobacco by hail was perhaps not over 3 per cent.

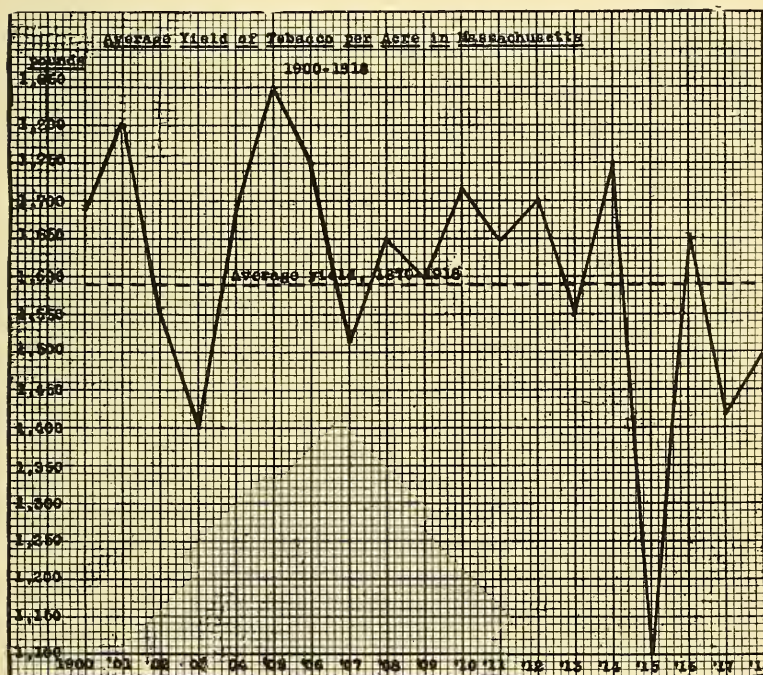


FIG. 5. — Average yield of tobacco per acre in Massachusetts, 1900-18.

The production per acre and the total farm value per acre for the chief tobacco-producing states are given in the following table. It is evident that the largest per acre yields in the United States are still reported from the Connecticut valley tobacco fields.

TABLE 18. — *Production and Farm Value per Acre in 1917 of the Principal Tobacco States.*

	Production (Pounds).	Value.
New Hampshire, ...	1,670	\$450 90
Vermont, ...	1,650	445 50
Massachusetts, ...	1,409	541 06
Connecticut, ...	1,400	537 60
Pennsylvania, ...	1,400	294 00
New York, ...	1,250	275 00
Florida, ...	1,100	627 00
Georgia, ...	1,000	570 00
Ohio, ...	960	240 00
Wisconsin, ...	950	166 25
Kentucky, ...	900	204 30
Tennessee, ...	810	137 70
Maryland, ...	790	158 00
South Carolina, ...	710	164 01
Virginia, ...	700	185 50
North Carolina, ...	630	198 45
Average, ...	826.30	\$205 20

COST OF PRODUCTION.

The tobacco grower has felt war conditions keenly. Prices of cloth, twine, glass, fertilizer, implements, labor, paper and other materials necessary in the production of tobacco have advanced very materially since the war began. It costs far more to produce an acre of tobacco to-day than it did prior to the war.

The average farmer does not know what it costs to raise his crop because he keeps no record of expenses. Of those who endeavor to keep accounts, very few enter all the items of expense in production.

Below is an accurate cost account kept by a tobacco grower in Massachusetts, on blanks prepared and sent out by the Massachusetts Agricultural College for that purpose. The expenses are for 1917 on a farm comprising 50 acres of tobacco, — 35 acres of shade-grown and 15 acres of primed Havana seed. He kept a separate account for each variety. It cost this grower \$629.38 per acre, or 74 cents a pound, to grow his shade tobacco, which averaged 850 pounds to the acre. He sold on contract for 90 cents a pound, or an average of \$765 per acre. The profit was \$135.62 per acre.

This cost is less than the actual expense, since it does not include depreciation on wire, posts, etc., and does not cover laths and glass which

were on hand from the previous year. The cost for a beginner ranges from \$1,000 to \$1,100 an acre. The tools and implements mentioned were used on the total 50 acres, so the amount used on the 35 acres was estimated from the total. The investment in machinery per acre is reasonable.

TABLE 19. — *Cost of Producing an Acre of Shade-grown Tobacco.*

Value of land, ...	\$340 00	
Rent (interest calculated at 5 per cent), ...		\$17 00
Tools, implements, etc.:—		
3 plows at \$12, ...	\$36 00	
3 Acme harrows at \$27, ...	81 00	
1 fertilizer sower, ...	48 00	
1 wheel harrow, ...	48 00	
1 Meeker harrow, ...	27 00	
1 roller, ...	25 00	
2 tobacco setters at \$95, ...	190 00	
4 Planet, Jr., cultivators at \$17, ...	68 00	
1 stalk cutter, ...	25 00	
Total, ...	\$548 00	
Total per acre, ...	10 96	
Interest on value of equipment, ...		55
Taxes, ...		3 40
Depreciation on equipment at 15 per cent, ...		1 65
Cloth (5,000 yards at 5½ cents), ...		287 50
Man labor, 513.8 hours at 30 cents, ...		154 14
Horse labor, 100 hours at 25 cents, ...		25 00
Shed rent, ...		4 29
Fertilizer for beds, ...		64
Glass for beds, ...		31
Timothy for cover crop, ...		47
Soft coal, ...		23
Manure, ...		20 97
Paris green for poisoning cutworms, ...		83
Water piping, ...		21
Sewing twine, ...		97
Stringing tickets, ...		035
Wool twine, ...		1 06
Jute twine, ...		62
Tobacco baskets, ...		64
Molasses, ...		048
Bran for cutworms, ...		91
Hose, ...		52
Guy wire clamps, ...		16
Sewing needles, ...		032
Tobacco plants, ...		08
Shed repairs, ...		30
Insurance, ...		70
Fertilizer, ...		100 00
Fertilizer V. C., ...		1 50
Cottonseed meal, ...		3 66
Freight on tobacco, ...		96
Total per acre, ...		\$629 38
Total per pound, ...		74

TABLE 20. — *Cost to the Landowner of Producing an Acre of Sun Tobacco.*

Value of land, ...	\$350 00	
Rent (interest calculated at 5 per cent), ...		\$17 50
Tools, implements, etc.:—		
Walking plow, ...	\$6 25	
Broadcast fertilizer sower, ...	12 00	
Tobacco setter, ...	23 75	
Wheel harrow, ...	12 00	
Acme harrow, ...	6 75	
Planet, Jr., cultivator, ...	4 25	
Tobacco press (simple, farm-made), ...	1 25	
4 hatchets, ...	50	
2 stringing horses, ...	1 25	
For an acre, ...	\$68 00	
Depreciation on equipment per acre, \$68 at 15 per cent, ...		10 20
Depreciation on sheds, \$700 at 5 per cent, ...		35 00
Taxes, ...		6 00
Insurance, ...		2 00
Fertilizer, 2,000 pounds at \$60 per ton, ...		60 00
Manure, 3 cords at \$10, ...		30 00
Labor:—		
Making seed bed, 2 men, one day, ...		6 00
Weeding and attention to plant beds, ...		6 00
Applying manure, ...		3 00
Plowing land, ...		8 00
Harrowing and ridging, ...		5 00
Drawing and setting plants, ...		7 00
Cultivating and hoeing 4 times, 2 men, eight days; 1 horse, four days, ...		36 00
Topping, worming and suckering, ...		25 00
Harvesting, 6 men, 2 teams, one day, ...		28 00
Taking down and stripping, 6 men, one day, ...		18 00
Bulking, ...		3 50
Delivering 3 miles at 10 cents per 100 pounds, ...		1 40
Feed, ...		20 00
Seed, 1 ounce, ...		1 00
Twine, ...		50
Paper, ...		3 00
Charcoal, ...		1 30
Oil, ...		1 00
Horseshoeing, ...		1 00
Veterinary, ...		15
Total per acre, ...	\$335 55	
Total per pound, ...		24

TABLE 21. — *Cost to a Tenant of Producing an Acre of Sun Tobacco.*

Value of land, ...	\$350 00
Rent of land, sheds and cold frames and laths (land, \$60; sheds, \$30; cold frames and laths, \$5), ...	\$95 00
Interest and depreciation on investment in tools (calculated), ...	4 00
Fertilizer, 2,000 pounds at \$60 a ton, ...	60 00
Manure, 3 cords at \$10, ...	30 00
Labor:—	
Making seed bed, 2 men, one day, ...	6 00
Weeding and attention to plant bed, ...	6 00
Applying manure, ...	3 00
Plowing land, ...	8 00
Harrowing and ridging, ...	5 00
Drawing and setting plants, ...	7 00
Cultivating and hoeing 4 times, 2 men, eight days; 1 horse, four days, ...	36 00
Topping, worming and suckering, ...	25 00
Harvesting, 6 men, 2 teams, one day, ...	28 00
Taking down and stripping, 6 men, one day, ...	18 00
Bulking, ...	3 50
Delivering 3 miles at 10 cents per 100 pounds, ...	1 40
Feed, ...	20 00
Seed, 1 ounce, ...	1 00
Twine, ...	50
Paper, ...	3 00
Charcoal, ...	1 30
Oil, ...	1 00
Horseshoeing, ...	1 00
Veterinary, ...	15
Total per acre, ...	\$363 85
Total per pound, ...	26

The above tables (numbered 20 and 21), on the cost of producing sun tobacco, were taken from the records of growers, and presumably represent an average cost of producing the crop of 1917. The cost to the tenant is slightly more, which is justifiable considering the high rental value of land and sheds. Prior to the war the average cost of producing an acre of sun tobacco in the Connecticut valley was about one-third less than the cost in 1917, or from \$225 to \$250 per acre.

TOBACCO INSURANCE.

Because of the risks connected with growing tobacco, such as frequent hail and wind storms, farmers have made an effort to have their crops insured, and insurance companies have been quite willing to insure tobacco crops against damage by the forces of nature. The usual amount of insurance has been from \$100 to \$200 per acre, with \$150 an average. The premium has been about \$8 per \$100 of insurance, or \$8 to \$16 per acre, and is commonly payable at the time the crop is insured.

The insurance company usually adjusts losses by wind or hail by sending an adjuster to inspect the damaged tobacco. The adjuster frequently decides upon the percentage in this manner:—counting 16 leaves to a plant, if 8 are hail cut he allows 50 per cent. In 1916 one grower of Hatfield,

Mass., received \$700 for 12 acres insured at \$150 per acre. In the same year a grower in Hadley, Mass., received \$75 an acre on 12 acres insured for \$100 an acre, and \$6 an acre on 5 acres insured for \$100 an acre. Another grower in Easthampton got \$150 an acre on 11 acres insured at \$150 per acre.

Insurance of the crop has been very helpful to tobacco farmers living in sections of excessive hail and wind storms, but it has not been successful in regions of little or no hail and wind. The insurance premium is high, and the maximum insurance is much less than the value of the crop. Moreover, farmers frequently pay out more money than they receive in damages. However, in 1917 and 1918 insurance companies were not eager to insure crops in regions of general hail and wind storms. Where they would insure the crops they put the premium so high that farmers felt they could not afford it. This lack of insurance puts the risk all on the farmer. In case of hail or wind storms he loses all. Crops are still insured in sections where hail and wind storms are rare.

TENANCY.

In 1910, 92 per cent of all Massachusetts farms were operated by owners,¹ 7 per cent by cash tenants, and 1 per cent by share tenants. In Connecticut, 90 per cent of all farms were operated by owners, 9 per cent by cash tenants, and 1 per cent by share tenants.

In Franklin, Hampden and Hampshire counties, Massachusetts, in 1910, 92.8 per cent of the farms were operated by owners, 4.5 per cent by cash tenants, and 2.7 per cent by share tenants. In Hartford, Litchfield and Tolland counties, Connecticut, 90.9 per cent of the farms were operated by owners, 5.5 per cent by cash tenants, and 3.6 per cent by share tenants. In the Connecticut valley 91.7 per cent of all farms were operated by owners, 5.3 per cent by cash tenants, and 3 per cent by share tenants. In fact, these two states exhibit an unusually large percentage of ownership. Very little change has occurred in this respect since 1880.

On the basis of tobacco alone, the percentage of tenancy is more than the above figures indicate. The proportion of tenants engaged in the growing of tobacco is comparatively high, since tobacco is a crop that lends itself readily to tenancy. It is a cash crop of large money value, requiring comparatively little machinery or horse labor, and adapted to hand labor, making the rise from tenancy to ownership comparatively easy. Most of the tenant farms are operated by immigrant families, the women and children doing much of the hand labor required for growing and preparing the crop for market.

Two types of tenancy are found in the valley, although but one is common. The one may be called share rental and the other cash rental. Share rental is usually for one-half the crop. Under this form the owner pays for the fertilizer in addition to supplying all the power machinery.

¹ "Owners" include farms operated by managers.

He also hauls his share of the tobacco to the warehouse. All the renter furnishes is his share of the seed, the labor and smaller implements required to grow and harvest the crop.

Cash rental is now the most usual form of tenancy in the valley, although share rent was more common in 1890. The cash rent paid for desirable tobacco land is from \$50 to \$60 per acre. The landowner furnishes nothing but the land. The cash tenant requires some capital; generally, however, he has no trouble in buying his fertilizer and implements on credit. By beginning as laborers, and taking advantage of this form of tenure, many Polish immigrants soon rise to farm ownership.

TENANCY IN THE CONNECTICUT VALLEY, 1880-1910

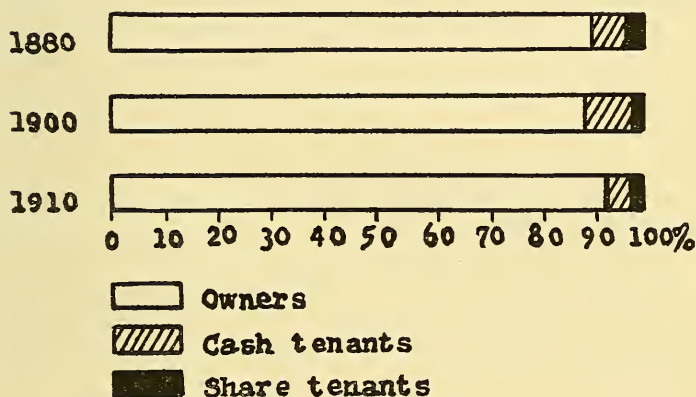


FIG. 6. — Tenancy in the Connecticut valley, 1880-1910.

PART II.

MARKETING CONNECTICUT VALLEY CIGAR LEAF TOBACCO.

NEW ENGLAND TOBACCO DISTRICTS.

The office of the United States Commissioner of Internal Revenue has divided New England into three districts, as follows: The States of New Hampshire, Vermont and Maine comprise the district of New Hampshire; in 1917 there were no dealers in leaf tobacco in the district of New Hampshire. The District of Massachusetts comprises the State of Massachusetts; in this district in 1917 there were 42 registered dealers in leaf tobacco. The Connecticut District includes the States of Connecticut and Rhode Island; in 1917 this district had 86 registered dealers in leaf tobacco.

SALE OF LEAF TOBACCO.

In this study an effort is made to trace the handling of unmanufactured tobacco from the producer to the manufacturer.

Tobacco passes through the hands of several middlemen from the time it leaves the farmer until it is ready to be manufactured. A brief discussion of these middlemen is in order. Fortunately the Commissioner of Internal Revenue has carefully defined the functions of most of these distributors, jobbers excepted.

*Persons involved.*¹

Dealers in Leaf Tobacco. — A dealer in leaf tobacco is any person whose business it is, for himself or on commission, to sell, offer for sale or consign for sale on commission leaf tobacco. Dealers in leaf tobacco may sell to three classes only: (1) to other registered dealers in leaf tobacco; (2) to qualified manufacturers of tobacco, snuff or cigars; and (3) to persons who are known to be purchasers of leaf tobacco in packages for export.

Retail Dealers in Leaf Tobacco. — A retail dealer in leaf tobacco is any person whose business it is to sell leaf tobacco in quantities less than an original hogshead, case or bale, or who sells directly to consumers or to persons other than dealers in leaf tobacco; or to manufacturers of tobacco, snuff or cigars, or to persons who purchase in original packages for export.

Certain restrictions are imposed on retail dealers: first, they can handle only unstemmed leaf tobacco in the natural leaf, which is in the hand and not manufactured or altered in any manner, and which has been grown

¹ Cf. United States Internal Revenue Report for July 1, 1910.

in the United States; and second, they can purchase from two sources only, — (1) from a farmer or grower from whom they may purchase in any quantity and in any form of package; and (2) from another retail dealer in leaf tobacco, in which case the purchase must be less than an original hogshead, case or bale. Retail dealers cannot purchase or sell stems, scraps or any refuse arising from the handling of leaf tobacco by any other person, and must confine their business to dealing in tobacco in its natural state, — in the hand and unmanufactured.

The sales of retail dealers are likewise limited and must be made in quantities of less than an original hogshead, case or bale. A qualified retail dealer in leaf tobacco may sell leaf tobacco acquired by him to any person except manufacturers of tobacco, snuff, cigars and cigarettes, dealers in leaf tobacco, or persons who purchase leaf tobacco in original packages for export. Retail dealers in leaf tobacco are not permitted to manipulate the leaf tobacco sold by them by sifting, twisting, screening, plaiting, sweetening, flavoring, pressing or by any other process of manufacture.

Jobbers. — A jobber is a buyer and seller of packed tobacco. Often he is a speculator rather than a packer; his functions are purely commercial. He carries a stock throughout the year to meet the demands of the manufacturers. In doing this he runs the risk of shrinkage, which in itself amounts to a considerable percentage, and of a fall in prices. He also has the expense of insurance and interest. The services of the jobber relate less to local consumption and more to the demands of outside trade. His work is to distribute the supply to the centers of manufacture.

Sale by Manufacturers. — It is lawful for any licensed manufacturer of cigars to purchase leaf tobacco of any licensed dealer or other licensed manufacturer in quantities less than an original package for use in his own factory exclusively. A manufacturer of tobacco or cigars, therefore, has the right to sell leaf tobacco to a cigar manufacturer under the conditions named.

The sale and transfer of leaf tobacco by manufacturers is restricted to the return or sale of such tobacco as is found unsuitable for use in their own factories, for the purpose of closing the factory, or otherwise, but in emergency cases only.

Sale by Farmers or Growers. — A grower may sell his own leaf tobacco to any person and in any quantity, provided the condition of such leaf tobacco has not been changed in any manner from that in which it was cured on the farm. Unrestricted sales may be made in hogshead, case or bale, or loose in the hand. The farmer or grower may also sell in the same manner leaf tobacco received from his tenants as rent for land. These privileges are personal and cannot be delegated by the farmer to another person.

An agent may solicit orders for the sale of leaf tobacco for the farmer by sample, but the deliveries must be made by the farmer himself directly to the purchaser.

SALE OF UNSTEMMED LEAF TOBACCO.

Statistics furnished by the United States Commissioner of Internal Revenue, representing the sales of unstemmed leaf tobacco by dealers in leaf tobacco in the districts of Massachusetts and Connecticut to manufacturers and dealers in these and other districts from March 31, 1915, to April 1, 1916, are depicted in Map 4 and Table 22.

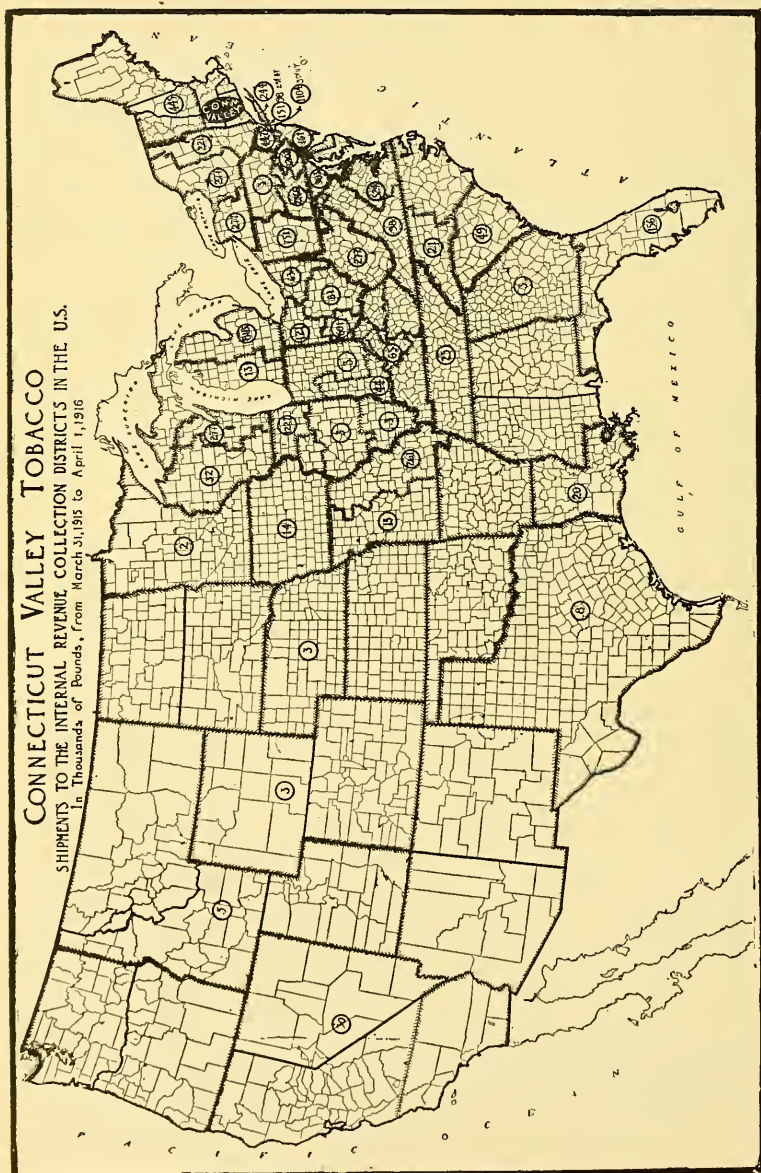


TABLE 22. — Sales of Tobacco from Massachusetts and Connecticut to Manufacturers and Dealers (Pounds).

	SALES TO MANUFACTURERS BY QUARTERS ENDING —				Yearly Total to Manu- facturers.	SALES TO DEALERS BY QUARTERS ENDING —				Yearly Total to Dealers.	Total to Manu- facturers and Dealers.
	June 30, 1915.	Sept. 30, 1915.	Dec. 31, 1915.	Mar. 31, 1916.		June 30, 1915.	Sept. 30, 1915.	Dec. 31, 1915.	Mar. 31, 1916.		
California, ...	—	—	—	4,282	4,282	6,412	1,881	12,188	5,385	25,866	30,148
Colorado, ...	1,249	—	926	942	3,117	—	—	—	—	—	3,117
Connecticut, ...	47,327	54,189	50,999	47,145	199,660	36,872	27,809	405,005	444,200	913,886	1,113,546
Florida, ...	14,812	68,132	23,456	40,021	146,421	3,944	316	—	5,368	9,628	156,049
Georgia, ...	885	500	1,147	530	3,062	—	—	—	—	—	3,062
Illinois, ...	4,238	27,471	39,191	36,263	107,163	196,388	298,369	288,398	339,228	1,122,333	1,229,546
Indiana, ...	8,493	13,796	11,607	12,183	46,079	—	539	—	—	539	46,618
Iowa, ...	257	1,400	10,885	1,343	13,885	—	—	—	—	—	13,885
Kentucky, ...	29,563	6,748	17,293	9,853	63,457	—	1,585	—	—	1,585	65,042
Louisiana, ...	795	473	3,325	5,293	10,486	1,487	1,461	1,517	4,846	9,311	19,797
Maryland, ...	23,813	26,602	43,518	32,769	126,702	212,750	209,736	288,123	145,777	856,386	983,088
Massachusetts, ...	24,408	25,545	25,139	22,891	97,983	939,213	49,814	201,669	290,144	1,480,840	1,578,823
Michigan, ...	85,287	192,205	292,007	118,117	687,616	54,575	19,282	51,123	18,393	143,373	830,989
Minnesota, ...	437	—	305	—	742	281	1,131	261	—	1,673	2,415
Missouri, ...	172	—	550	1,546	2,268	73,486	84,589	38,625	66,157	262,857	265,125
Montana, ...	260	265	—	—	525	—	—	—	—	—	525
Nebraska, ...	—	2,735	—	202	2,937	—	—	—	—	—	2,937
New Hampshire, ...	84,166	150,335	69,798	140,639	444,938	—	—	—	—	—	444,938
New Jersey, ...	99,711	120,402	219,748	150,071	589,932	371	1,450	—	16,859	18,680	608,612
New York, ...	189,800	214,242	247,372	289,796	941,210	7,643,957	2,626,881	2,837,894	5,763,129	18,871,861	19,813,071
North Carolina, ...	—	—	13,947	7,415	21,362	—	—	—	—	—	21,362
Ohio, ...	79,198	75,546	136,357	160,988	452,089	298,636	177,165	183,827	325,005	984,633	1,436,722
Pennsylvania, ...	112,204	83,248	70,718	105,448	371,618	807,322	838,103	1,357,295	1,348,677	4,351,397	4,723,015
South Carolina, ...	21,304	7,738	14,760	5,052	48,894	—	—	—	—	—	48,894
Tennessee, ...	4,978	8,091	2,478	7,110	22,657	—	—	—	—	—	22,657
Texas, ...	—	238	535	—	773	—	—	—	—	—	773
Virginia, ...	—	—	8,392	—	8,392	38,422	226,330	138,503	113,271	516,526	524,918
West Virginia, ...	1,001	1,221	3,316	712	6,250	45,472	—	21,878	24,317	91,667	97,917
Wisconsin, ...	—	1,920	—	145	2,065	35,885	92,939	78,446	99,878	307,148	309,213
Totals, ...	834,358	1,083,042	1,308,269	1,200,856	4,426,525	10,395,473	4,659,380	5,904,752	9,010,634	29,970,239	34,396,764

The sales to manufacturers amounted to 4,426,525 pounds, and to dealers, 29,970,239 pounds, a total for both manufacturers and dealers of 34,396,764 pounds for the period. Of this total, 19,813,071 pounds went to the State of New York alone, and 4,723,015 pounds went to Pennsylvania. The remainder, approximately one-third, was distributed rather generally over the other states east of the Mississippi River and in some states west of it.

For the four quarters ending March 31, 1917, the sales of unstemmed leaf tobacco from the Connecticut valley to dealers and manufacturers in the same and other districts amounted to 30,368,117 pounds, or about 12 per cent less than for the four quarters ending March 31, 1916.

One reason for the wide distribution of Connecticut valley cigar leaf tobacco is the great demand for wrapper leaf of a superior quality. The other cigar leaf producing states are mainly producers of either the binder or the filler type of leaf, inferior in wrapper quality. The imported Sumatra is the only cigar leaf wrapper competing with the Connecticut valley leaf in this country, and the imports of this have fallen off since 1914.

TABLE 22(a). — *Sales of Unstemmed Leaf Tobacco by Farmers in the Connecticut Valley, 1915-19, by Quarters.*

	1915.	1916.	1917.	1918.	1919.
January, February, March, ...	—	13,145,562	14,607,796	49,794,150	36,994,438
April, May, June, ...	8,288,532	6,011,579	7,818,773	14,089,663	—
July, August, September, ...	702,528	1,016,090	2,045,304	2,995,224	—
October, November, December, ...	5,383,787	6,081,221	30,230,690	18,953,141	—
Totals, ...	—	26,254,452	54,702,563	85,832,178	—

During the four quarters ending March 31, 1916, the total purchases of unstemmed leaf tobacco from farmers in the Connecticut valley amounted to 27,520,409 pounds, and for the four quarters ending March 31, 1917, to 27,716,686 pounds. The largest purchases were made from January to March, amounting to nearly one-half the total purchases. The next largest purchases were from April to June, and the smallest amounts were purchased during the quarter from July to September.

The above data show in a general way the breadth of the market for New England-grown tobacco. The demand in the different sections varies from year to year, and the extent to which New England tobacco fills the demand also fluctuates seasonally, depending, of course, upon the quantity of first-class tobacco produced. The market always demands wrapper leaf of the quality grown in the Connecticut and Housatonic valleys. When, however, there is an exceptionally large yield of light wrappers of fine quality, for example, the manufacturer who uses light wrappers

will buy heavily and hold a portion of his purchases in his own or a local warehouse. This reserve may be sufficient to supply his wants without large additional purchases the following season, provided quality and prices are not satisfactory. Owing to the high prices and the poor quality of tobacco in New England in 1917, many dealers made little effort to purchase from the farmers, but used instead their reserve stores from the 1915 and 1916 crops. This fact is a partial explanation of seasonal and yearly variations in purchases.

CIGAR LEAF TOBACCO HELD BY MANUFACTURERS AND DEALERS.

The war in Europe brought about conditions in the tobacco world never before dreamed of. The United States has produced but one-third of the world's supply of tobacco; the other two-thirds have heretofore been grown in various parts of Europe. Europe is not yet in a condition to raise much tobacco, and it may be years before normal conditions can be brought about. Food crops naturally receive first attention. Hence for years to come we are likely to see a continuance of high prices for tobacco.

The table below gives the total consumption, production and imports of tobacco for specified countries before the war.

TABLE 23. — *Total Consumption, Production and Imports of Tobacco for Specified Countries before the War (Pounds).*

COUNTRY.	Average Annual Con- sumption.	Average Annual Pro- duction, 1909-13.	Average Annual Imports, 1909-13.
World, ...	—	2,712,204,000	—
Total for countries enumerated, ...	2,259,000,000	2,061,519,400	358,927,601
United States, ...	786,000,000	996,175,000	52,767,739
India, ...	481,000,000	450,000,000	6,537,759
Germany, ...	222,000,000	66,935,800	168,436,515
Austria Hungary, ...	209,000,000	178,994,400	49,983,593
Russia, ...	179,000,000	210,808,000	—
Great Britain, ...	98,000,000	—	112,334,018
France, ...	96,000,000	40,959,800	63,918,094
Japan, ...	91,000,000	93,611,600	—
Italy, ...	54,000,000	22,199,800	47,731,626
Netherlands, ...	43,000,000	1,829,000	57,218,267

The United States, Russia and Japan are the only countries enumerated that produced prior to the war more tobacco than they consumed. Russia is producing practically none now, and other European countries are pro-

ducing far below normal. This means that the United States must supply this enormous tobacco deficit. But how well prepared are we at the present time to supply this deficit? Our position in regard to cigar leaf is indicated in the following table:—

TABLE 24. — *Cigar Leaf Tobacco held by Manufacturers and Dealers.*

	Oct. 1, 1915.	Oct. 1, 1916.	Jan. 1, 1917.	Jan. 1, 1918.
United States, ...	335,367,657	270,275,297	231,737,847	223,432,876
New England, ...	57,771,149	54,528,973	50,602,672	51,722,780
Broadleaf, ...	31,217,506	29,884,371	26,276,744	21,670,911
Havana seed, ...	24,359,058	22,731,599	21,849,157	26,262,206
Shade-grown, ...	2,194,585	1,913,003	2,476,771	3,789,663
New York, ...	—	3,989,282	3,065,209	2,558,481
Pennsylvania, ...	105,460,066	79,294,496	69,536,194	62,969,786
Ohio, ...	74,329,126	59,913,485	50,303,531	52,589,602
Wisconsin, ...	78,891,003	59,783,228	46,473,396	40,714,197
Georgia and Florida, ...	8,515,339	7,697,077	6,567,538	5,213,161
Porto Rico, ...	5,888,910	4,780,971	4,567,256	7,307,787
All other domestic, ...	261,576	287,785	622,051	357,082
Imported types, ...	63,658,729	58,290,911	54,768,526	59,397,226

The total stocks of cigar leaf tobacco in the hands of manufacturers and dealers have steadily decreased in the last few years. The quantity on hand on Jan. 1, 1917, amounted to 231,737,847 pounds, and on Jan. 1, 1918, to 223,432,876 pounds, a decrease of 8,354,971 pounds in one year. Since Oct. 1, 1915, the stocks of cigar leaf tobacco have decreased 111,934,781 pounds, or 33 per cent. The decrease in New England has not been so rapid as in New York, Pennsylvania, Wisconsin, Georgia and Florida. The states of New York and Pennsylvania are by far the largest manufacturers of cigars in the United States, New York alone having received over 18,000,000 pounds of Connecticut valley leaf in 1916 to say nothing of large receipts from other cigar producing states.

The above figures only partly tell the story. They represent the quantity of leaf tobacco reported as held by manufacturers and dealers who, according to the returns of the Commissioner of Internal Revenue, manufactured during the preceding calendar year more than 250,000 cigars, or had on hand more than 50,000 pounds of tobacco. What about the small manufacturers who, in the scramble for the 1916 and 1917 crops, were unable to get their quota? Since the war the large manufacturers have entered the field on a wholesale scale, and have outbid the smaller concerns for the leaf. Consequently, if we could take into account the smaller dealers and manufacturers, this reduction in cigar leaf would be even more striking.



FIG. 7. — One method of hauling tobacco from field to curing shed.

The production of cigar leaf tobacco in the United States has remained practically the same from 1912 to 1917. With the crop of 1917 smaller by 5,000,000 pounds than the 1916 crop, and the production in the European countries very materially decreased, it became necessary for European countries to secure the larger part of their tobacco from this country. Our exports of all kinds of tobacco leaf and trimmings to some countries have considerably increased, while to others the increase has not been large, owing to the lack of transportation facilities.

PREPARATION FOR MARKET BY THE GROWER.

Harvesting.

Three methods of harvesting tobacco are in vogue in the valley to-day. The first two described below have been in practice for years; the third is a new method that is gaining in favor. The first is "hanging on lath." The plants are cut close to the ground with a thin-bladed hatchet made for the purpose. They are then laid lengthwise of the row and overlapping each other. When wilted they are handed to the "stringer" who strings them on a lath. One end of the lath is attached to a "stringing horse" and the other end is fitted with a steel needle. The plants are strung on the lath by forcing the needle through the butts of the stalks about 6 or 8 inches from the end, five or six plants being strung on a lath. The full lath is placed on a wagon fitted with a rack made to prevent the plants from being broken while being hauled to the curing sheds. The laths are arranged in the curing sheds so that each end of the lath rests on a pole. These poles are usually 15 feet long and allow room for 25 to 30 laths.

"Hanging on string" is the second method of harvesting tobacco, and many growers favor it above all others. The plants are cut as before, only they are laid crosswise of the row, and after being allowed to wilt are loaded directly on low wagons, the butts all laid one way. The plants are then drawn to the shed, where they are hung on poles with twine. The hanger carries a bag on his back, which holds a ball of twine. With this he hangs the plants about 8 inches apart on the poles by tying a half hitch around each plant. When the pole is full the end of the twine is tied around the last plant.

Priming.

This is a method of harvesting tobacco which came in with the shade-grown industry and has found favor among many growers of sun-grown tobacco. The barn is differently arranged, with the tiers only half as far apart as in the methods previously described. The plant is not cut, but the leaves are picked or "primed" as they ripen, four or five leaves at a time at intervals of from seven to ten days. The bottom leaves are picked first and the top leaves last. The pickers walk between two rows, priming both and placing the leaves in little piles. These piles are gathered up, placed in baskets and drawn to the end of the row on a hand truck. There they are loaded on a wagon and hauled to the shed where they are strung

on poles. Generally the stringing is done by women and children, with large needles, placing about forty leaves on a string. The ends of the string are knotted and hung on a lath which has been notched at the ends. These laths are then hung up tier after tier. In a few days the second priming begins, and so on until the crop is harvested. Sometimes it is possible to cure and take down the first priming before the last is made, thus giving a chance to use the shed a second time in the same season. Consequently primed tobacco takes less shed space than that harvested by other methods. When the crop is to be primed it is not necessary to top the plant, thus saving considerable labor.

Curing.

The curing shed is really one of the limiting factors to increased production. To hang an acre of tobacco requires a shed 30 by 30 feet. A building of this size will cost from \$450 up, depending upon whether it is of frame or of pole construction. In 1916 it cost from \$700 to \$800 to construct a frame shed of sufficient size to hold an acre of tobacco. The frame shed is constructed so that every third board is a trap door which can be opened for purposes of ventilation. The pole shed is built by setting the posts in the ground, and is not framed, the braces being nailed on. This type of shed is not so common now as it was a few years ago.

After the crop is placed in the shed the grower must watch it closely, opening the ventilating doors on certain days and closing them on others, depending upon the weather. Crops are ruined each year by neglect of this matter. With tons of water in the crop which must be evaporated within a few weeks, this is a critical time for the grower. Too much moisture in the atmosphere retards evaporation. Then, too, there is danger of "pole sweat." In a dry season, with the doors open all the time, the tobacco will dry, and not cure. In recent years the majority of growers have used the fire-cure method, building a charcoal fire under each bent in the shed, and thus to some extent becoming independent of the weather.

Taking down.

As soon as the crop is cured it is taken down. The tobacco has changed from a heavy green leaf to a thin light brown one, and has become so dry that it will easily crumble. Therefore, to get the crop down whole, it must be handled in damp weather when the leaf is said to be in "case." "As soft as a kid glove" is an expression often used in describing this condition. When this warm, rainy weather, or "tobacco damp," comes, no matter if in the middle of the night or on Sunday, the grower gets all the help he can command, and takes down as much tobacco as he thinks he can strip before it dries. With the lath method the laths are simply slipped off the poles, and, with a man on each tier, are handed very carefully and quickly to the man on the floor. There the tobacco is removed from the laths and piled with the butts laid both ways. If piled too high,



FIG. 8 — Cutting tobacco. Much of this work is done by boys.



FIG. 9. — Stringing tobacco on a lath fastened to a stringing horse.

early in the fall when the stalks are green, there is more danger of the tobacco heating.

When hung on a string, a man at each end of the pole pushes the tobacco into a bunch in the middle of the pole. One man with a sharp knife then cuts the string, another hands the bundle to the man lower down, and it is piled as before.

Primed tobacco is simply stripped off the string and at once made into bundles.

A tobacco damp lasts only a short time, and the farmers must get down as much tobacco as possible. To keep the tobacco from drying as soon as it is taken down, it must be covered in order to shut out the wind and retain the moisture. The crop after it is taken down must be kept damp and the shed closed as tightly as possible to keep out the wind.

Stripping.

As soon as possible after the tobacco is taken down stripping begins. With the stripping crew on either or both sides of the pile a section is uncovered, each plant is taken up, and the leaves rapidly picked off one by one. The stripper holds the stalk in one hand and strips the leaves with the other, beginning at the butt. The leaves are placed in the stripping boxes which are of different sizes, 36 by 12 by 12 inches being about the average. The box is made with one side hinged. First, string is placed in the box at four different places, then the box is lined with paper. After the box is full the paper is brought over the top, the strings tied, and the bundle taken out of the box by opening the hinged side. The bundles vary in weight, but average from 35 to 40 pounds each. The bundles are then ready for delivery to the place agreed upon at the time of sale, either to a local sorting or packing shop or shipping point.

Hauling to Market.

Through personal investigation it has been found that the most common initial haul from the field to the sorting shop or shipping point in Massachusetts is about 3 miles, but some farmers haul their tobacco less than 1 mile, while others haul 10 miles or more. Transportation charges vary according to the distance from the farm to the shipping point, and from the shipping point to the manufacturer.

An average two-horse load contains about 150 bundles of tobacco of 30 pounds each, or 4,500 pounds. Two loads per day would make 9,000 pounds. The team and driver cost about \$9.50 per day. This would make the cost per pound of tobacco \$0.00106, or a little over one-tenth of a cent per pound, or 10 cents per 100 pounds.

As a matter of fact, the cost of hauling tobacco from the farm to the warehouse or shipping point is very insignificant, since such a large value can be hauled at a load. The tobacco is mostly hauled on sleds during the winter months while snow is on the ground, which makes it possible to haul a load of very large bulk, weight and value.

Large growers, notably growers of shade tobacco, ship some tobacco to dealers and manufacturers, but very little tobacco is shipped by farmers. Most of the tobacco is sold by the farmer to local packers who pack, sweat and sell it in the case, or in the bundle to other packers, dealers or manufacturers. The steps in marketing performed by the farmer are now ended. Before the packers are ready to market the crop it must go through several stages of preparation, which will be discussed in the next few pages.

DESCRIPTION OF PACKERS' PREPARATIONS FOR MARKET.

Functions of the Packer.

The first function of the packer is to purchase from farmers the quantity of tobacco of the grade desired by the trade which he supplies. He does this himself or through his local agent. The local agent is usually a prominent grower who owns a building equipped for receiving, sorting, packing, sweating and storing tobacco. Frequently these buildings, fully equipped, are built by dealers for their local agents. In other cases they are leased for a period of years, but usually they are owned by the local agent, who receives a fixed price per pound or case for packing the tobacco.

The second function of the packer is to receive the tobacco at the sorting shop. Very frequently it is purchased in the field long before it is ready to harvest, and naturally there is no assurance as to the condition of the crop when it comes from the curing shed. When tobacco is delivered at the warehouse it is inspected, and if too much damaged is refused or accepted at a reduced price. Much damage may result from taking down tobacco too dry or too damp. Farmers are usually paid in full as soon as the tobacco has been accepted and weighed at the packer's warehouse.

The third function of the packer is to open the bundles and deliver the tobacco to the sizers, who separate the leaves one by one according to length. Then the different sizes are taken to the sorters who grade them according to quality and color.

The fourth function is sorting. As a rule, no attempt at sorting is made by the farmer. He simply delivers his bundles of stripped tobacco. The sorting is usually done by some one hired by the packer. This agent gets his help ready to begin about November 10, and continues until about the first week in April.

For the fifth function the tobacco thus sorted is tied with short tops into hands. These hands are placed in stalls properly labeled, and covered with blankets to keep the tobacco "in case."

The sixth function is packing and sweating. From these stalls it is put into cases lined with paper, and the tobacco is so placed, with the tips toward the center, as to lap from 4 to 6 inches. The lap is necessary in order to start sweating. The cases are then moved into the sweat room.



FIG. 10. — Hauling to market. Unloading bundles at one of the sorting shops.

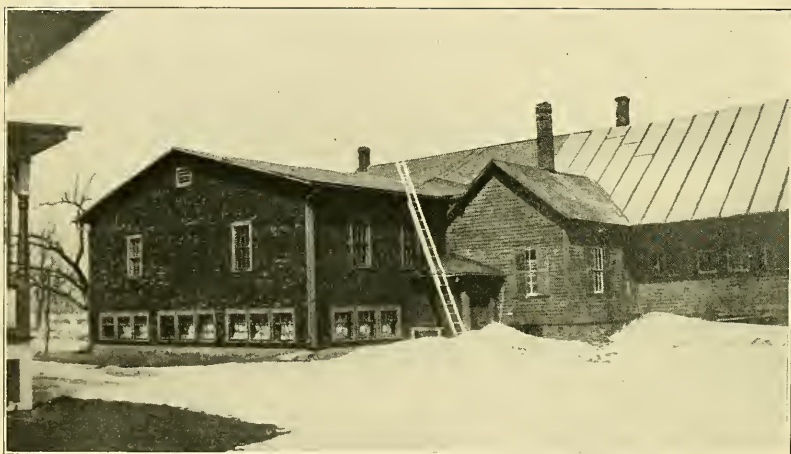


FIG. 11. — A typical shop for sorting sun-grown tobacco. Note the windows at the bottom, which furnish light for the sorting tables.

The seventh function is sampling. After a case comes out of the sweat and is cooled to normal, it is opened and four hands are taken from various parts of the case and tied together as a sample, which is guaranteed in any part of the United States.

Sorting and Tying. — When the tobacco comes into the sorting shops from the farm it is loose in the bundle and is not graded. This tobacco needs to be assorted according to grade, length, texture and color, and tied in small bundles of from fifteen to twenty leaves, called hands. This means a lot of labor, for each leaf must be handled. This kind of work is mainly done by women and children.

Each sorter has a sorting table consisting of boxed-off compartments from 10 to 12 inches deep and 8 to 10 inches wide, and of varying lengths, perhaps 16 to 22 inches, to fit leaves of different sizes. Each leaf is placed in the compartment corresponding most closely to its length, and with skilled labor no time is wasted in placing the leaves in their proper places. The leaves of different grades are kept separate, — light wrappers, dark wrappers, medium wrappers, broken, seconds, fillers and binders. The various grades are packed in hands of from fifteen to twenty leaves each, tied with a leaf of tobacco; then the tobacco is ready to be packed in cases and placed in the sweating room.

Sweating. — There are three methods of fermentation, or sweating, now in use in the Connecticut valley. By the first and most common method from 300 to 350 pounds of sorted leaf tied in hands are tightly and smoothly packed into a wooden box which is fairly tight on the sides, but with one-half inch spaces between the end boards. The leaf is packed with the tips toward the center and the butts toward the ends of the case. The cases are piled in an unheated storehouse as they are packed, turned once or twice, and after lying over one summer are sampled and ready for sale to manufacturers or jobbers.

This is the natural method, but in recent years a method known as "forced sweating" has been largely used in order to get tobacco into market quickly, or to finish tobacco which has not fermented enough. The tobacco, packed in cases, is kept for about six weeks in a room with a moist atmosphere maintained at 90° to 120° F. This method enables the packer to clean out his sweat room and put in a fresh supply of tobacco every five or six weeks, and consequently he is not crowded for space.

The "bulk method" of sweating is used to some extent for Havana seed and exclusively with shade-grown, though it has not been successful with broadleaf. With the bulk method, the sweat room is kept at a temperature of from 80° to 90° F., with humidity high enough to keep the leaf soft. Under these conditions the bulk immediately heats and fermentation proceeds rapidly. As soon as the thermometer inside the bulk shows a temperature of 110° to 130° F., the bulk is pulled down, the leaf lightly shaken out and immediately bulked again, putting that leaf which was on the outside of the former bulk on the inside of the new one.

In the new bulk the rise of temperature is slower. This operation of rebulking is continued until the leaf is finished.

The following record from an experiment at the Connecticut Agricultural Experiment Station shows the temperature which may prevail within a bulk from the day it is laid down:—

TABLE 25. — *Temperature of Bulked Tobacco.*

	Degrees F.
When built, ...	73
December 19, ...	85
20, ...	99
21, ...	113
22, ...	121
Shaken out and bulked again.	
December 23, ...	86
24, ...	92
25, ...	97
26, ...	104
28, ...	112
31, ...	115
January 1, ...	114
Shaken out and bulked again.	
January 3, ...	94
5, ...	99
7, ...	104
9, ...	108
11, ...	107
23, ...	100

The above represents one of the first experiments with bulk sweating, which was conducted by the Connecticut Experiment Station in co-operation with the United States Department of Agriculture in 1898. The results were satisfactory and this method is now widely used.

Fermenting tobacco containing from 18 to 25 per cent of moisture is germicidal in its action, and few if any bacteria are found on freshly fermented leaves. Fermentation is due to the soluble ferments or enzymes found in the growing plant, and perhaps also while wilting after harvest. The enzymes are not living organisms like microbes, but chemical bodies which under proper conditions cause extensive chemical changes. The main changes are caused by two oxidizing enzymes, by the action of which the oxygen of the air is made to unite with various compounds in the leaf. To this action chiefly is due the color and aroma of fermented leaf, the presence or absence of which either makes a cigar of high burning qualities, rich and flavored, or a cigar of no body and very poor burning qualities. The burning quality of tobacco cannot be determined until after it is taken from the sweat shop.

Tobacco loses in sweating and shrinkage about 15 per cent, which is an item to be considered by the packers. A case weighing 300 pounds when put into the sweat room will weigh only about 255 pounds when it comes out. The packer guarantees the case not to shrink more than a certain maximum, usually from 15 to 20 per cent.

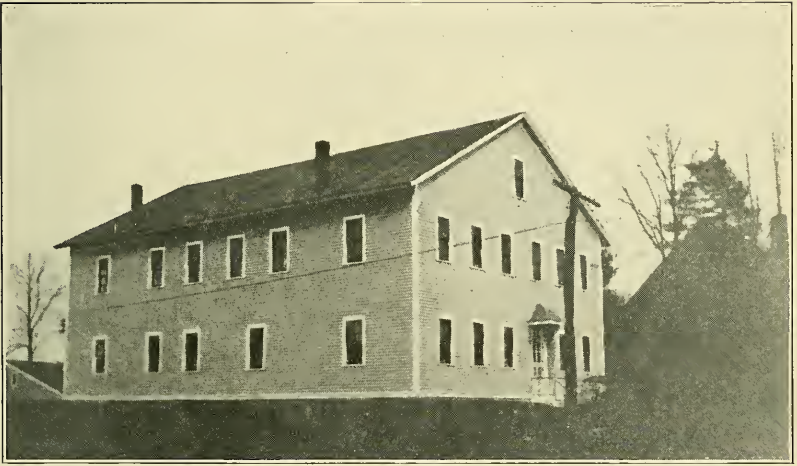


FIG. 12. — A shade-grown sorting shop. The sorting is done in the basement, and the top stories are used for storage.

Sampling. — Sampling is generally done by a special sampler appointed by his firm, though sometimes it is done by a local packer appointed by the company for which he packs. The sampler charges 35 cents a case, one-half of which goes to the sampler and the other half to his firm. This fee of 35 cents does not include handling. It is estimated that it costs 15 cents to handle the cases and to deliver the samples to the manufacturer, making the total charge 50 cents per case.

Tobacco is sampled as soon as it comes from the sweat room by taking six hands from different places in a case. Beginning at the bottom a sample is taken from about every fourth layer of tobacco. From these six samples four are selected to represent the quality of the bale, and are tagged and numbered to correspond to the number on the bale from which the sample was taken. This sample is guaranteed anywhere in the United States to represent the quality of tobacco in the case.

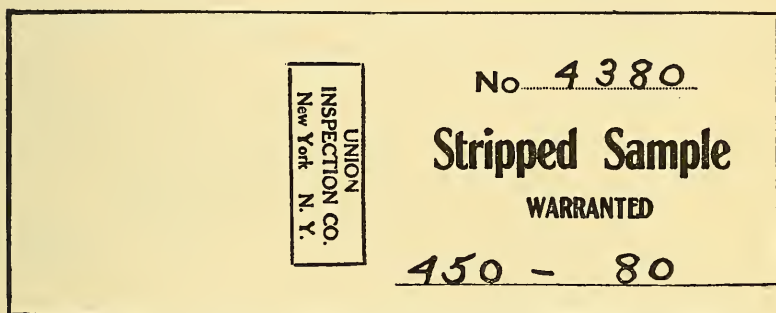


FIG. 13. — Tobacco sample tag, tied to the hands, and guarantees the tobacco anywhere in the United States. The number of the case here is 4380, the gross weight 450 pounds and the tare 80 pounds.

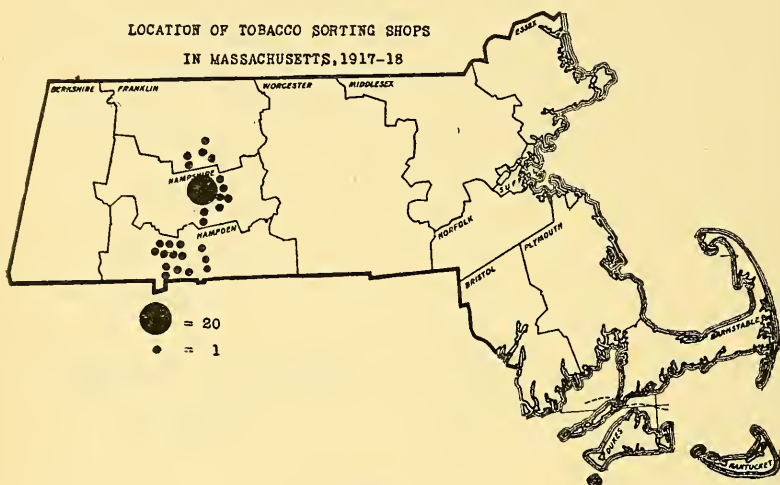
Amount of Tobacco assorted.

There were 7,280 cases of shade-grown tobacco assorted, sweated and stored in the warehouses of Massachusetts in 1917-18, and 35,971 cases of sun-grown tobacco, representing a combined total of 11,883,200 pounds. In 1917-18 there were 44 sorting shops open in Massachusetts which handled about 270,070 pounds per shop on an average. Some of these shops do a much larger business than others, depending upon the size of the shops and the number of laborers employed.

Nearly one-half of the Massachusetts tobacco is grown by Poles, and from one-half to three-fourths of the laborers employed in the sorting and packing shops are of Polish descent. In Connecticut Polish labor is not so important as in Massachusetts. Three-fourths or more of the tobacco in Connecticut is grown by natives, and over one-half of the labor employed in the sorting shops is native. The Polish farmers utilize the help of the whole family during the growing season and in the sorting shops during the winter months.

Sorting Shops.

Map 5 shows the location of these sorting shops in Massachusetts. During the sorting season of 1917-18 there were 46 tobacco sorting and packing shops employing 2,832 laborers, an average of 62 laborers per shop. Twenty of these local sorting shops, nearly one-half, are located in Hatfield, including North Hatfield and Bradstreet.



MAP 5.

TABLE 26. — *Tobacco Sorting Shops in Massachusetts, 1917-18.*

LOCATION.	Number of Shops.	Laborers employed.
Hatfield, ...	20	1,319
Hadley, ...	5	230
South Deerfield, ...	1	75
Sunderland, ...	1	25
Chicopee, ...	1	215
Westfield, ...	8 ¹	212
Southwick, ...	1	60
Feeding Hills, ...	1	- ²
Springfield, ...	2	510
Agawam, ...	1	6
Easthampton, ...	1	40
Northampton, ...	1	60
Whately, ...	3 ¹	80
	46	2,832

¹ One closed 1916-17.² Labor transferred to Springfield.

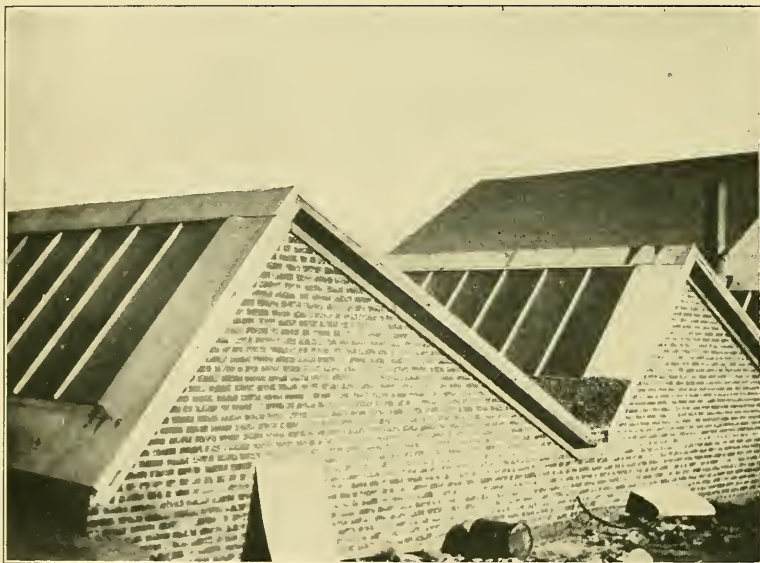


FIG. 14. — Showing the roof of a sorting shop for shade-grown tobacco. Note the glass roof to provide light for the sorting tables.

TABLE 28. — *Size of Cases and Pounds per Case.**Lights and Seconds.*

LENGTH OF LEAVES (INCHES).	Size of Case (Inches).	Pounds per Case.
16, ...	42	320
18, ...	32	250
20, ...	36	270
22, ...	38	290
24, ...	42	310
26, ...	44	325

Darks and Mediums.

16, ...	42	350
18, ...	32	310
20, ...	36	320
22, ...	38	330
24, ...	42	350
26, ...	44	360
28, ...	44	370
Fillers, ...	42	350
Brokens, ...	38	350

Summary.

In 1915 the packers estimated that it cost them $3\frac{1}{2}$ cents a pound to sort, tie, store, pack, sweat and sample their tobacco. This includes all labor, lumber for cases, nails, twine, paper, sampler's fee and other expenses connected with packing. In 1916 the packers estimated their cost at 5 cents a pound. The depreciation on buildings and equipment, cost of heating, lighting, taxes, etc., are not included in the above. Including these last-named items, the 1916 cost was about 7 cents per pound. In 1917 the packers estimated that processing and marketing cost them, from the time the tobacco reached their hands until delivered to the manufacturer, wholesaler or jobber, 11 cents a pound for sun-grown tobacco, and 28 cents a pound for shade-grown.

TABLE 29. — *Cost of Packing a 350-Pound Case in 1917-18.*

Shrinkage, 10 per cent at 30 cents, price paid farmer, ...	\$10 50	
Sweating, 5 per cent at 30 cents, price paid farmer, ...	5 25	
		\$15 75
Paper, 1 pound at 11 cents, ...	\$0 11	
Price of white pine case, ...	2 50	
Nails for case, ...	03	
Twine, 1 pound at 20 cents, ...	20	
Labor:—		
Tying 350 pounds at \$1.25 per 100, ...	4 37	
Sorting 350 pounds at \$1.30 per 100, ...	4 55	
Packing, ...	1 50	
Sampling, ...	35	
Cartage and inspection, ...	15	
		13 76
Price paid producer for 350 pounds at 30 cents, \$105; interest on \$118.76 (\$105+\$13.76) at 6 per cent, ...	\$7 13	
Storage, 1 year (including taxes and insurance), ...	50	
Light, ...	10	
Heat, ...	1 00	
Transportation to New York at 20 cents per 100 pounds, less shrinkage and sweating, ...	60	
Office help, ...	20	
Collecting, ...	10	
Depreciation on buildings, \$5,000 at 5 per cent on basis of cases packed, ...	54	
		10 17
Total cost per case, ...	\$39 68	
Cost per pound, ...		113

Labor and all materials connected with packing have advanced since 1914. For the season of 1917-18 paper cost the packers about 11½ cents per pound. Three sheets weigh 1 pound and will line a case. Wire nails cost about \$6 per keg. Cases have also advanced considerably. Table 27 gives the relative sizes and costs of cases for sun-grown tobacco in 1916. Add 90 cents per case to obtain the cost in 1917.

STORAGE.

Tobacco is a product which, in contrast to the great bulk of products, requires a period of storage before it is desirable for consumption. At least six months are required for the natural sweating and packing process, and from five to eight weeks for forced sweating. The longer tobacco is in storage the better the quality. It can be held two, three, five or even more years without any deterioration in quality. Some large firms advertise their product by some such catchy phrase as "mellowed by age." This is one reason why it is so easy to regulate prices; crops are safely held over from years of overproduction to years of underproduction, although since 1914 we have been drawing heavily on our reserve supply. Consequently the length of time in storage depends to a large extent upon market conditions. In general, we may say that tobacco is in storage six to eight months, although the periods range from two months to two years.

Little tobacco is stored by the producer for any length of time. Instances occur, however, where it is necessary for the grower to hold some of his crop after it is taken from the poles. In such cases it is packed into bundles and stored in a tightly closed shed or sorting room to prevent drying. When prices are low some farmers store and sweat their tobacco, hoping to sell at an increased price. Though there is a good opportunity for co-operative warehouses, nothing has yet been done along this line. The essential features of this plan will be discussed later.

Tobacco warehouses in the Connecticut valley are all privately owned. The big storage plants are under the control of the packers. Each dealer who has a sufficiently large business has at least one warehouse and sometimes several. These warehouses are usually constructed with the sorting rooms partly under ground, but so arranged that good light is available for sorting tables. The storage room is above the sorting room, so arranged that it is convenient to move the tobacco from the sweating room into the storage after it has been packed.

Besides the storage by packers or dealers, the manufacturers store large quantities of tobacco, sometimes buying when tobacco is plentiful and holding until an off year. Table 24, on page 180, gives the amount of tobacco stored by manufacturers and dealers for a number of years.

Cost of Storage.

Cost of storage varies with the time the crop is stored and the time the sweating occupies. Figures for the leaf-producing sections of Pennsylvania give the cost of storing the case for one year as 50 cents. The costs of inspection, sampling, etc., amount to 50 cents. There is also a shrinkage during storage which amounts to about 15 per cent. The total cost of storage for a year and the attendant labor amounts to about \$2 per case.

The packers in the Connecticut valley estimated that it cost 11 cents a pound to handle the 1917-18 tobacco crop from the time it reached their hands until it was delivered to the purchaser. This figure is sufficiently large to cover all expenses of packing and selling. At this figure the packers could sell for 45 cents tobacco purchased from the farmers for 30 cents a pound, making a clear profit of 4 cents per pound sold. Wholesale prices, however, lead to the conclusion that far bigger profits are made.

TRANSPORTATION.

TABLE 30.—*Freight Rates to Principal Manufacturing Centers.*

	From North Hat- field Station (Cents).	From South Deer- field Station (Cents).
New York City, ...	20.5	21.0
Elmira, N. Y., ...	21.5	21.5
Washburn, N. Y., ...	21.0	—
Harlem River, N. Y., ...	16.8	16.8
Syracuse, N. Y., ...	20.0	20.0
Erie, N. Y., ...	18.0	—
Troy, N. Y., ...	15.0	—
Philadelphia, Pa., ...	24.0	24.0
Lancaster, Pa., ...	24.0	24.0
York, Pa., ...	24.0	24.0
Lititz, Pa., ...	21.0	21.0
Norristown, Pa., ...	21.0	21.0
Newark, N. J., ...	21.0	21.0
New Brunswick, N. J., ...	16.8	—
Cleveland, Ohio, ...	26.1	—
Chillicothe, Ohio, ...	29.8	29.8
Miamisburg, Ohio, ...	32.0	32.0
Chicago, Ill., ...	36.8	36.8
Detroit, Mich., ...	28.7	28.7
Duluth, Minn., ...	39.0	—
Wheeling, W. Va., ...	28.0	25.1
Kansas City, Mo., ...	42.0	—
Los Angeles, Ca., ...	39.0	—
Springfield, Mass., ...	15.0	15.0
Lowell, Mass., ...	17.5	17.5
Hartford, Conn., ...	12.0	12.0
Hamilton, Ont., Can., ...	25.7	28.0
Montreal, Can., ...	27.5	23.9

These are not the only cities that receive tobacco shipped from North Hatfield and South Deerfield, Mass., over the Boston & Maine Railroad. The foregoing table simply shows the wide distribution of sales and the comparatively low freight rates to the principal shipping points. For example, 100 pounds of tobacco can be shipped from North Hatfield, Mass., to Los Angeles, Cal., for 39 cents, or a little over one-third of a cent per pound.

*Shipments and Receipts of Tobacco, Massachusetts Local Shipping Points,
1915-17.**Shipments (Tons).*

	1917.	1916.	1915.
January, ...	714.2	845.00	424
February, ...	576.5	831.00	415
March, ...	543.2	558.50	440
April, ...	855.5	504.00	450
May, ...	319.7	307.00	438
June, ...	452.0	501.00	314
July, ...	316.4	223.90	731
August, ...	386.5	297.29	693
September, ...	242.9	269.00	181
October, ...	268.1	271.65	695
November, ...	248.5	197.00	413
December, ...	301.2	276.00	555
Total (tons), ...	5,224.7	5,081.34	5,749
Total (pounds), ...	10,449,400	10,162,680	11,498,000

Receipts (Tons).

January, ...	307	275	187
February, ...	154	136	238
March, ...	57	76	30
April, ...	36	59	32
May, ...	10	21	9
June, ...	20	6	91
July, ...	53	47	20
August, ...	30	30	26
September, ...	23	26	32
October, ...	57	45	14
November, ...	95	120	60
December, ...	109	96	77
Total (tons), ...	951	937	816
Total (pounds), ...	1,902,000	1,874,000	1,632,000

Note the heavy shipments for January, February, March and April of 1916 and 1917. The great demand for all classes of cigar leaf tobacco and the high prices offered by the manufacturers resulted in early ship-

ments by the packers. The heavy shipments from July to December 1915, are the result of holding the 1914 crop for higher prices. Tobacco was not high in price at this time, but, on account of the war, dealers predicted a rapid rise in prices and held a large part of the crop.

The shipments for May and June are small for the three years; and July for 1916 and 1917. The sorting season is then over and the packers store tobacco for fermentation by the natural process during the summer months.

Most of the tobacco received from outside sources comes in during the months of November to February, when tobacco is being sorted. The buyers frequently import tobacco from other localities to be sorted in their shops.

Records of shipments and receipts were obtained from South Deerfield, Hadley, North Hatfield, Hatfield and Whately, Mass. Subtracting the receipts from the shipments, for the tobacco received is included in that shipped out, 9,866,000 pounds were shipped from these local stations in 1915; 8,288,680 pounds in 1916; 8,547,400 pounds in 1917. These shipments amount to about 3,000,000 pounds less than the annual production in Massachusetts. These 3,000,000 pounds not included in the shipments are probably shipped from stations in Hampden County, notably Westfield, Springfield and Chicopee.

GRADES, STANDARDS AND PRINCIPAL VARIETIES.

Tobaccos are divided into "classes," a "class" signifying the purpose for which the product is finally intended. Thus we have pipe, cigar, chewing, export and cigarette classes, and these are subdivided into various "types," depending upon certain qualities of the leaf, such as color, flavor, elasticity and strength.

Further divisions into "grades" are almost endless in variety, based on the differences in size, aroma, texture, quality, etc.

While sizes and grades vary somewhat among different packers, the following grades and sizes are common for sun-grown tobacco:—

GRADES.	Inches.
1. Light wrappers, ...	14, 16, 18, 20, 22, 24, 26, 28.
2. Medium wrappers, ...	20, 22, 24, 26.
3. Dark wrappers, ...	16, 18, 20, 22, 24, 26, 28.
4. Seconds, ...	16, 18, 20, 22, 24, 26.
5. Broken, ...	Broken leaves and all under 14 inches.

Connecticut valley shade-grown tobacco is assorted into grades according to color, texture and lengths.¹ The chief colors are: —

L No. 1,	.	.	.	.	.	.	.	.	Light color.
CL No. 2,	.	.	.	.	.	.	.	.	Light color.
LV No. 1,	.	.	.	.	.	.	.	.	Light green.
V,	.	.	.	.	.	.	.	.	Full green.
VV,	.	.	.	.	.	.	.	.	Dark green.

The texture is graded into light wrappers, medium wrappers and heavy or dark wrappers. Sizes run from 9 to 22 inches, and are measured by the inch. On an average there are about 60 grades and sizes to a crop, but sometimes there are as many as 250 grades and sizes.

In an average year about 25 per cent of the Connecticut valley tobacco crop goes for wrappers, Massachusetts and Connecticut producing a large quantity of wrappers of high quality. About 50 per cent of the crop is used for binders and 25 per cent for fillers.

The grades of tobacco are determined by the quality and length of the leaf. Those which are of fine texture, glossy, thin and silky make the best wrappers. Leaves of poorer and heavier quality are used for binders, and the short broken leaves are used for fillers.

In the shade-grown industry the grades are not so carefully distinguished there being many grades of slight variation. Therefore it is more difficult to grade shade-grown tobacco. The determining qualities are about the same as in the sun-grown. A very thin, silky leaf with open grain makes a high-priced wrapper.

PRICES.

Supply and Demand.

The price of tobacco is determined by the quality of the leaf and the comparative demand for it. Overproduction of any special kind of tobacco lowers prices, although this is not so marked as with some other products, because the keeping qualities of tobacco are good, and buyers frequently purchase when the supply is plentiful and hold the product for manufacture until there is a short crop. Tobacco two or three years old is better than tobacco freshly packed and fermented.

On the other hand, during a year of low production the demand will exceed the supply, and prices are bound to rise. During 1916 and 1917 there was a great demand for all grades of tobacco, and consequently prices were unusually high. Production did not increase sufficiently to satisfy the larger population demand; moreover, the per capita consumption of tobacco has likewise increased. The annual per capita consumption of all forms of tobacco in the United States from 1863 to the present time is presented below.

¹ Some of the grades occurring in the crops assorted at the shop of Mr. Leslie Swift, North Hatfield, Mass., during the sorting season of 1917-18, are as follows: —

L 18.	L 11.	LL No. 2 15.	LV 15.	V No. 1 16.	V No. 2 16.
L 15.	LL 20.	LV 20.	LV 14.	V No. 2 20.	V $\frac{1}{2}$ No. 2 15.
L 12.	LL No. 2 18.	LV 16.	MW 16.	V No. 2 18.	Broken 15.

Pounds

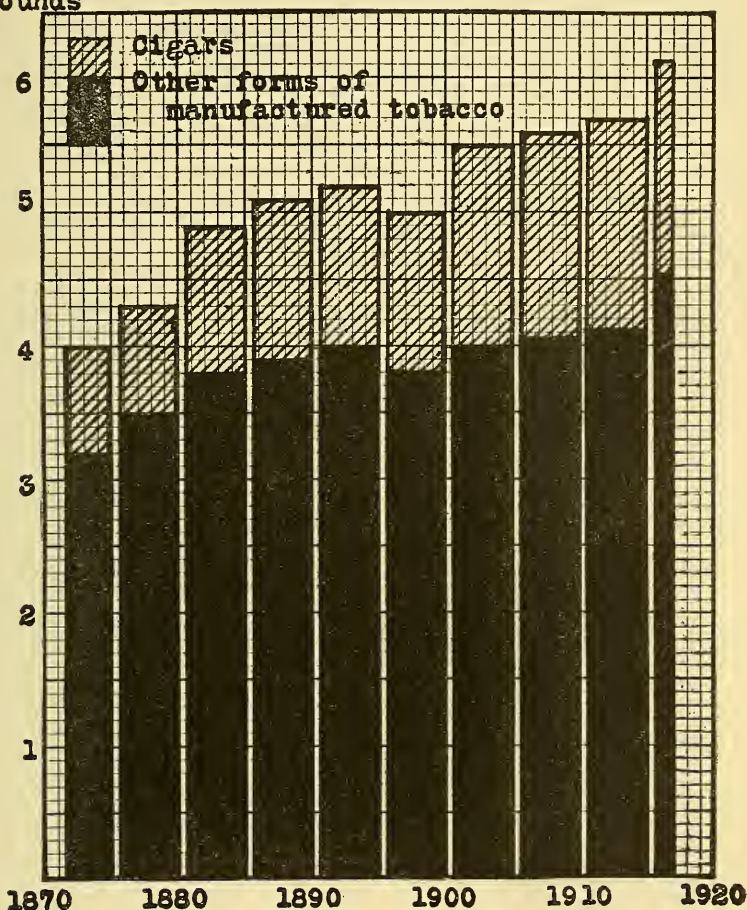


FIG. 15. — Per capita consumption of cigars and other forms of manufactured tobacco in the United States, 1870-1917.

TABLE 31. — *Annual Quantity per Capita of Leaf Tobacco manufactured in the United States (Pounds).*¹

YEARS.	All Tobacco.	Cigars.	YEARS.	All Tobacco.	Cigars.
1872-75, . . .	4.0	.79	1896-1900, . . .	5.00	1.20
1876-80, . . .	4.3	.80	1901-05, . . .	5.50	1.54
1881-85, . . .	4.9	1.11	1906-10, . . .	5.60	1.57
1886-90, . . .	5.1	1.19	1911-15, . . .	5.70	1.58
1891-95, . . .	5.2	1.18	1916-17, . . .	6.12	1.60

¹ Internal Revenue Reports, 1872-90, estimated.

Per Capita Consumption for Different Countries (Pounds).¹

	1871-75.	1876-80.	1881-85.	1886-90.	1891-95.	1896-1900.	1901-05.	1913.
United States, ...	4.0	4.3	4.9	5.1	5.2	5.0	5.5	5.70
Germany, ...	3.9	3.7	3.0	3.3	3.3	3.5	3.5	3.77
France, ...	1.7	1.9	2.0	2.0	2.1	2.1	2.1	2.43
England, ...	1.3	1.4	1.3	1.4	1.6	1.8	1.9	2.05

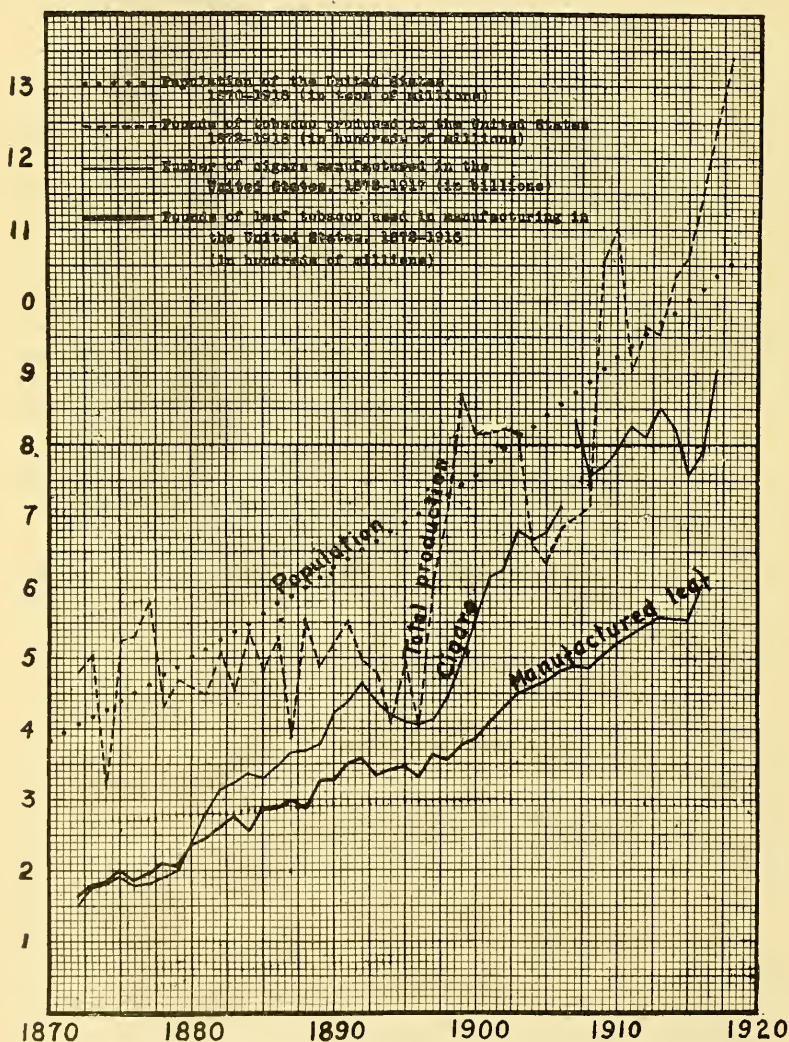
¹ Adapted from Jacobstein, *The Tobacco Industry*, p. 44.

FIG. 16. — Notice the tendency of tobacco production, the number of cigars and the amount of manufactured leaf to follow the upward trend of population.

The United States is by far the greatest consumer of tobacco, using one and one-half times as much as Germany, the next largest consumer, in 1913. From 1872 to 1913 the per capita consumption of tobacco in the United States increased 42.5 per cent, in England 58 per cent, in France 43 per cent, and in Germany decreased 33 per cent.

In 1875 the per capita consumption of cigars in the United States was about .8 of a pound; in 1916 to 1917 it was 1.60 pounds, an increase of about 100 per cent. During this period the per capita consumption of plug, smoking and chewing tobacco increased 28 per cent; from 1900 to 1918 the total cigarette production increased over 900 per cent, and the per capita output of cigarettes increased approximately 740 per cent. This indicates the increasing demand for cigars and cigarettes in comparison with other tobaccos.

Connecticut Valley Tobacco in the Market.

Map 4 shows the shipments of Connecticut valley cigar leaf tobacco to districts within and without Connecticut and Massachusetts. This map also shows the chief manufacturing and consuming centers; for example, in 1916 the state of New York received 18,871,861 pounds of Connecticut and Massachusetts wrapper; Pennsylvania received 4,351,397 pounds.

The Connecticut valley produces a high grade of wrapper tobacco which is famous the world over. A cigar wrapped with a Connecticut wrapper bears its own trade-mark. No other section of this country, barring a small area in Florida, is so well suited to producing high-grade wrapper tobacco.

Methods of Sale.

There is no organized market for leaf tobacco grown in the Connecticut valley. Most of it is sold to "packers," manufacturers or dealers in leaf tobacco, who act as packers as well as jobbers. Many of these packers and dealers have a local representative or agent who may or may not purchase from the farmer.

As a rule, the grower sells to so-called "tobacco buyers," who may be local dealers in leaf tobacco, local agents for so-called "packers," representatives of manufacturers, or traveling buyers for wholesale dealers in leaf tobacco. These buyers purchase the growers' crops by the pound, to be delivered stripped and tied in bundles at one of the local sorting shops. Practically all the tobacco is sold in this way. Of course there are still some farmers, especially large growers, who keep their help throughout the year and pack and grade their own tobacco and sell it in cases directly to manufacturers or jobbers.

Tobacco in the Connecticut valley may be sold either before or after harvesting. Sales consummated before the tobacco is harvested, or by the "contract method" of sale, are made in two ways:—

1. The grower contracts to grow a certain number of acres of a certain kind of tobacco to be delivered at a specified price and place in good merchantable condition.

2. While the crop is growing it may be sold at a fixed price per pound, to be delivered on or before a certain date at a warehouse or shipping point agreed upon at the time of sale and in specified condition. In all cases of sale by contract the buyer makes a payment on the crop when he contracts for it in order to make the contract binding, to which both buyer and seller agree. This method is very common when the crop looks promising and the tobacco outlook is satisfactory, especially after a poor year from the standpoint of both yield and quality. A large proportion of the 1916 crop was sold in the field because of the anxiety of the buyers to procure a supply after the disappointing season of 1915.

Harvested tobacco may be sold as follows: —

1. After the tobacco is cured and stripped it may be sold to be delivered as agreed upon at the time of sale at a certain price per pound, or to be assorted into certain grades with a price for each grade, or a flat price for all grades.

2. After the grower has assorted his crop he may sell it by grades or for a flat price for all grades.

3. The grower may assort and case his crop, sweat it and put himself in the position of a tobacco dealer. This last method is adopted only by large growers who have sufficient capital to carry a crop.

In the marketing of tobacco the buyer has every advantage. He knows the condition of the market. The farmer, on the other hand, is primarily a grower, and as a usual thing wants to sell when the crop is harvested. Lack of operating capital often forces the farmer to sell early. The small grower is obliged to sell immediately because he needs the cash to pay bills, purchase farm supplies and plant a new crop.

Under the contract method of sale the farmer has all to lose, with no corresponding gain, the buyer, little or nothing. With one the matter is intensely personal, with the other entirely impersonal. The buyer represents big organization familiar with trade conditions, prospective consumption and competing agencies. If the buyers do not work together they are not as shrewd business men as the writer gives them credit for being. It would be good business. The farmers have done little collectively to obtain trade information or to control the mechanism of processing or distributing the product. Having no knowledge of the market, and not belonging to a farmers' shipping organization, he is at the mercy of the buyer. Perhaps the only way for the average farmer to improve his prospects is through some co-operative organization for collective bargaining, the purposes, organization and scope of which are discussed later in this bulletin.

Defects of the Contract Method of Sale.

1. Farmers naturally do not have as great interest in their crop after it is sold as before. They are likely to become careless in handling the tobacco.

No. South Windsor ^{March 9} 1917

This certifies to the sale to

C. F. Schoverding & Co

of my 1916 crop of Havana Seed

Broad Leaf Tobacco, consisting of about 30

acres, to be delivered, free from water, damage, and rubbish, when instructed by purchasers.

Price, ~~in the bundle~~, at 34 1/2 cents per pound:

Wrappers, 34 1/2 ¢

Long Seconds, 34 1/2 ¢

Short Seconds, 34 1/2 ¢

Tops, 34 1/2 ¢

Broken, Seconds, 15 ¢

Fillers,

Received Fifteen hundred on account

Name Nathaniel Jones

P. O. South Windsor

FIG. 17. — A tobacco grower's contract. Fifteen hundred dollars is paid down to bind the contract.

2. It is impossible to sell a crop on its merits. The tobacco is sold while it is growing or even before it is planted, and no one can tell what the quality of the crop will be after it is cured. It is simply a gamble; the buyer gambles for the grower's crop, and he endeavors to set the price sufficiently low to guarantee himself against loss.

3. It means frequent adjustments. Fifty per cent of the 1916 crop bought on contract was delivered at a discount. This statement comes from dealers and packers as well as farmers. The contract says that the tobacco must be delivered in good merchantable condition, free from water, damage and rubbish, when instructed by the buyer. This gives the buyer a large leverage, and it is comparatively easy for him to take the ground that a farmer's crop contains water or rubbish, and to dock him from 3 to 5 cents per pound.

4. The farmer is tempted to take his tobacco down too soon, which causes fatty stem; or he may sprinkle it to make it workable. The crop has been sold and he wants the cash as soon as possible.

5. The contract is drawn up by the buyer and does not bind him to the extent it does the farmer. The buyer is bound only to the extent that he must purchase the tobacco from the farmer, but not necessarily at the price agreed upon in the contract. On the other hand, the farmer must sell to the buyer even though he is docked 10 cents a pound; he can sell to no one else. A case occurred in 1917 where a farmer resold his tobacco to another buyer because of an advance in price. The first buyer brought suit and won, and it cost the farmer a large sum of money to get out of the difficulty.

6. Fifteen or twenty buyers in one locality or district at the same time necessarily mean a waste of time. Instead of buyers traveling over the valley for five or six months in the year, a much better plan would be for them to wait until the crop is harvested, cured and sweated, and the samples sent to some central selling office in New York or Hartford, where the buyers could collect and inspect the samples and leave orders for the grades they desire. Such a method of sale could be accomplished through a co-operative organization which would include the tobacco growers of the entire Connecticut valley.

Collusion among Buyers.

There is a very strong feeling among tobacco growers that the buyers have a working agreement or understanding among themselves as to the general average of prices to be paid. This is naturally a difficult matter to prove, but, considering their associations, dinners and frequent meetings, there is ground for the belief of the growers. It is reported that buyers first go over the tobacco territory apparently with no intention of purchasing. Occasionally a man will ask if they are buying tobacco, and they answer, "No; why? Have you some to sell?" If the grower says, "Yes," they ask his price; if it is high, they drive on, but if low, they purchase his tobacco. A few crops are thus purchased in each locality,

and these low prices are made the basis for future purchases. Sometimes a buyer will offer a farmer a fair price for his tobacco and the offer will be refused. A few days later a second buyer will come along and offer a price just a little lower, and a third buyer a price a little lower still. By this time the grower is growing fearful that he cannot sell his crop, so lets it go for a low price.

Apparently this is a scheme agreed upon by the buyers. In 1915 one man in the valley was offered 12 cents a pound for his tobacco, a little later 9 cents, and finally it sold for 6 cents. The quality of the crop was as good when it was finally sold for 6 cents as it was when the first man offered 12 cents. Other growers report similar experiences. This has been the practice in the Connecticut valley ever since the industry was established. The farmer who has held for a good price has frequently been boycotted by the buyers. Hence, reliable growers have had to sell crops of good quality at a low figure just because their neighbors sold early and at a low price.

This practice did not work well during the war because of the growing scarcity of tobacco. The growers who sold late in the season got the best prices. However, the old practice bids fair to be resumed just as soon as the supply of tobacco has been sufficiently increased. In fact, the decline in price, beginning about Oct. 1, 1918, was held by many to be due to the determined effort on the part of buyers to depress the price. From September, 1918, through January, 1919, few farmers received any offer whatever for their crops. A few were offered 25 to 30 cents a pound for tobacco for which formerly they had been offered 45 cents a pound.

Prices to Farmers.

As has been noted, tobacco is sold in the Connecticut valley by contract, the buyer frequently contracting for the grower's crop while it is growing or even before it is planted. This factor has probably been the main reason why prices to the farmer have been comparatively low. The crop has not been sold on its merits, and consequently the farmer has had to take whatever the buyer offered him. Fig. 17 shows that the supply and price of tobacco in New England bear very little relation to each other. For example, during the years 1910-12 the supply gradually increased, likewise the price. In 1912-13 the supply and the price quite uniformly decreased. In 1914-15 the supply decreased and the price also decreased, but not with any uniformity. The quality of the 1915 crop was, however, very poor. The only years that show any normal relation between the supply and price were 1904-05, 1913-14 and 1916-17. The great demand for tobacco from 1916-17 is the chief reason for the rapidly advancing price.

Ordinarily when the supply increases the price decreases, and *vice versa*, but no such relationship is exhibited in this figure. This is due partly to the fact that tobacco can be held for a number of years, permitting only slight fluctuations in prices. Partly, however, it is due to the fact that the

tobacco crop in competing areas may be large, while the Connecticut valley crop is small. Partly, too, it may be due to imports, but no doubt it is also in part attributable to the faulty method of sale.

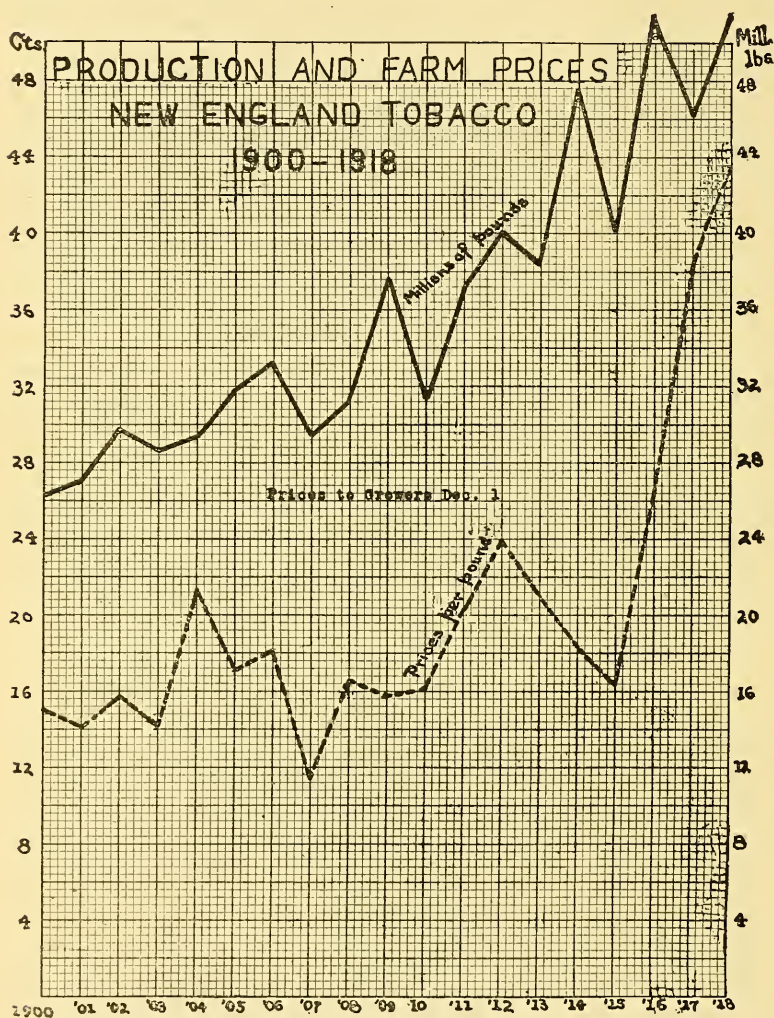


FIG. 18. — Production and farm prices of New England tobacco, 1900-18.

Prices of Connecticut valley tobacco have increased, however, since 1916, reaching the maximum in July, 1918, with an increase of 80 per cent over 1916. This increase was due to the great demand for low grades of leaf tobacco, and the decrease of the better grades through injury by storm and frost. The demand for low grades steadily raised the minimum price

until the price for average or binder goods naturally followed. The continued ravages of the elements during the growing season, culminating in the frost of September, 1917, naturally resulted in higher prices for the top grades. It is estimated that 40 per cent of the Connecticut valley sun-grown was injured by hail, wind or frost, while the loss in shade-grown was perhaps 3 per cent, nearly all caused by wind.

It would be difficult to indicate the average price for the 1917 crop because of damage by storm after contracts had been made in the field, and because of the almost unheard-of prices paid for damaged tobacco. But it is safe to say that prices ranged from 23 to 30 cents for the average run of stalk-cut Havana seed on early contracts, with the average at 26 cents and 30 cents for the leaf sold late. Primed Havana crops sold for about 34 cents, with the range from 28 to 45 cents. Broadleaf sold around 30 cents, with the range from 24 to 36 cents in the bundle, the latter price in South Windsor, Conn., for crops contracted late. Shade tobacco on contract ranged from 70 cents to \$1.10 in bundles, 85 cents being the prevailing price.

Prices prior to the war varied more or less from year to year. The crop of 1915 was very poor in quality and of light weight, and prices were consequently low, averaging only 14.5 cents in Massachusetts and 16.43 cents in all New England.

The crop outlook varied in the other cigar leaf sections. The growing conditions indicated in midsummer a 95 per cent normal crop in Pennsylvania, an 80 per cent crop in Wisconsin, a 90 per cent crop in Ohio, and a 90 per cent crop in New York. Frost seriously damaged the Ohio crop, striking also 30 per cent of Pennsylvania acreage and 35 per cent of Wisconsin acreage.

Binder shortage presented the greatest problem of the cigar industry. Instead of 100,000 cases of binders which Wisconsin produces in normal years, the 1917 crop did not produce more than 15,000 cases. About 48,000 acres were planted in 1917, and this compared favorably with the average for the last five years. The crop was planted under favorable conditions, chiefly in the last part of June and the early part of July. A period of extremely dry weather, the late planting and an early frost caused Wisconsin to face a discouraging outlook for a fair yield of good binders. About 5,000 acres were cut by hail; about 7,000 acres were shredded before the frost; about 26,000 acres were frozen, a small portion only yielding some binders; and about 10,000 acres were badly frozen in the fields. A late harvest and very poor curing weather added to the loss.

This absolute scarcity of binders brought about unheard-of prices. The manufacturers paid as much or more for binders in 1917 and early 1918 as they did for wrappers two or three years ago. Not only is there a strong demand for binders, but filler tobacco has increased in proportion more than either binder or wrapper tobacco.

TABLE 32. — *Prices received by Farmers in the United States, 1899, 1909.*¹

STATES.	AVERAGE VALUE PER POUND (CENTS).		AVERAGE VALUE PER ACRE.	
	1909.	1899.	1909.	1899.
New Hampshire, ...	13	15	\$232 96	\$256 15
Vermont, ...	11	15	169 09	272 61
Connecticut, ...	16	18	275 27	303 79
Massachusetts, ...	13	15	220 62	249 97
Florida, ...	29	23	257 20	123 64
Georgia, ...	20	14	146 75	69 30
New York, ...	08	08	97 96	103 67
Pennsylvania, ...	09	07	94 06	106 60
Ohio, ...	10	07	84 51	68 10
Wisconsin, ...	08	06	95 28	85 67
Kentucky, ...	10	06	84 86	48 19
South Carolina, ...	08	07	70 59	49 91
Virginia, ...	09	06	65 63	39 11
North Carolina, ...	10	06	62 41	39 59
Tennessee, ...	08	06	62 58	38 25
Maryland, ...	08	06	55 89	33 52
United States, average, ...	10	07	\$80 55	\$51 74

¹ United States Census, 1910.TABLE 33. — *Average Farm Price of Cigar Leaf per Pound, December 1 (Cents).*¹

	1900.	1905.	1910.	1915.	1917.	1918.
Connecticut, ...	15	17.0	16.5	17.0	38.4	44.0
Massachusetts, ...	15	16.9	15.0	14.5	38.4	40.0
New York, ...	8	10.5	8.5	9.5	22.0	30.0
Pennsylvania, ...	6	10.8	9.3	9.2	21.0	25.0
Ohio, ...	7	8.4	8.5	9.0	25.0	27.0
Wisconsin, ...	7	10.0	7.5	6.0	17.5	30.0

¹ United States Department of Agriculture Yearbook.

TABLE 34. — *Average Farm Price of Cigar Leaf per Pound in the Connecticut Valley (Cents).*

	Massachusetts.	New England.
1910, ...	15.0	12.91
1911, ...	18.0	18.10
1912, ...	20.9	21.06
1913, ¹	19.2	18.62
1914, ¹	17.7	18.32
1915, ¹	14.5	16.43
1916, ¹	18.0	19.20
1917, ¹	28.0	29.00

¹ Average prices for the season obtained from growers.TABLE 35. — *Average Farm Prices per Pound in Massachusetts in 1916.*
Franklin County.

	Average on 12 Best Farms.	Average on 58 Farms.
Number of acres, ...	9.10	6.71
Yield per acre (pounds), ...	1,610	1,541
Price per pound, ...	\$0.15	\$0.13
Total receipts, ...	\$2,235.00	\$1,299.00

Hampshire County.

	Average on 19 Best Farms.	Average on 83 Farms.
Number of acres, ...	22.0	11.6
Yield per acre (pounds), ...	1,679	1,678
Price per pound, ...	\$0.205	\$0.187
Total receipts, ...	\$7,527.000	\$3,645.000

Hampden County.

	Average on 10 Best Farms.	Average on 44 Farms.
Number of acres, ...	18.20	9.05
Yield per acre (pounds), ...	1,751	1,724
Price per pound, ...	\$0.27	\$0.224
Total receipts, ...	\$8,613.00	\$3,506.000

Average price on 41 best farms, \$0.208.
Average price on 185 farms, \$0.18.

TABLE 36. — *Farmers' Prices in Leading Producing Areas in the Connecticut Valley in 1917.*

	Per Pound (Cents).
North Amherst, Mass., ...	26
Sunderland, Mass., ...	27
Hatfield, Mass., ...	29
Hadley, Mass., ...	29
South Deerfield, Mass., ...	27
Westfield, Mass., ...	29
Average, ...	27.8
Windsor, Conn., ...	31
South Windsor, Conn., ...	32
Broadbrook, Conn., ...	28
Suffield, Conn., ...	30
Granby, Conn., ...	28
Average, ...	29.8

Wholesale Prices of Connecticut Valley Wrappers and Binders.

The following is a list of prices quoted to manufacturers printed by one of the largest leaf tobacco houses in the United States: —

TABLE 37. — *Wholesale Prices of Connecticut Valley Wrappers and Binders, February and March, 1918.**Connecticut Havana Seed Wrappers.*

Lot No.	QUALITY.	Price per Pound, Actual Weight.
197	Extra fancy, very light colors, ...	\$1 75
198	Fancy, packed Sumatra style, ...	1 25
199	Old-fashioned, sun-grown wrappers, medium colors, perfect burn, .	1 50
200	The finest East Hartford, light colors, ...	1 00
201	Extra fine, light colors, thin and silky, ...	90
202	Very fine, light colors, thin and silky, ...	85
203	Very fine, light to medium colors, ...	75
206	Our leader in splendid value, medium colors, ...	60
207	Medium to dark, leafy, fine quality and burn, ...	50
	Average, ...	\$1 01

TABLE 37. — *Wholesale Prices of Connecticut Valley Wrappers and Binders, February and March, 1918 — Concluded.**Connecticut Broadleaf Wrappers.*

Lot No.	QUALITY.	Price per Pound, Actual Weight.
218	Finest ever grown; fancy light, ...	\$1 50
219	The limit of good quality, ...	1 25
220	Perfect Havana colors, finest quality grown, ...	1 15
221	Very fine, Havana colors, perfect quality, ...	1 00
222	Extra fine, brown Havana colors, ...	90
223	Fine light to medium Havana colors, ...	75
224	Very fine, dark brown colors, strictly quality, ...	90
225	Rich Havana colors, ...	75
	Average, ...	\$1 02

Connecticut Primed Wrappers.

230	The very finest, light, primed wrappers, ...	\$3 00
231	Extra fine, light, primed wrappers, ...	2 50
232	Very fine, light, primed wrappers, ...	2 00
233	Our leader in fine, light, primed wrappers, ...	1 50
234	Light to medium primed wrappers, ...	1 00
235	Extra fine, medium to light, "workers,"	75
	Average, ...	\$1 79

Connecticut Havana Seed Binders.

239	The very finest Connecticut binders grown, ...	\$0 68
240	Extra fine, seconds, light colors, Suffield-grown, 22 to 24 inches, contains many wrappers, ...	65
241	Fancy East Hartford seconds, full and thin, ...	60
242	Fine East Hartford seconds, thin and silky, ...	50
246	Good East Hartford binders, slightly broken, ...	35
248	Medium to dark wrappers, ...	50
249	Same, thin, leafy binders, ...	40
	Average, ...	\$0 52

Connecticut Broadleaf Binders.

258	The very finest binders, a fine grade of seconds, ...	\$0 70
259	Fine South Windsor, full of light, medium wrappers, ...	60
260	Fancy seconds, ...	55
261	Fine seconds, quality the best, ...	50
262	Fine quality, very leafy binders, ...	40
264	Connecticut broadleaf top leaves, fine quality fillers, ...	45
	Average, ...	\$0 53

Another large cigar leaf tobacco house quoted practically the same prices to the manufacturers. These houses deal in good quality leaf, so that these prices are probably slightly higher than the average price paid by the manufacturer. Below is a list of wholesale prices obtained by interviewing the tobacco manufacturers in the valley, and from prices quoted by the Tobacco Merchants' Association of New York. These prices are certainly none too high, and presumably represent the average price paid by the manufacturer to the dealer for cigar leaf tobacco.

TABLE 38. — *Wholesale Prices of Havana Seed and Broadleaf.*

			Price		
Year 1915-16: —			Per Pound.		
Light wrappers,	.	.	\$0 60-	\$0 70	Average .46.
Medium wrappers,	.	.	35-	45	
Dark wrappers,	.	.	30-	35	
Spring of 1917: —					
Light wrappers,	.	.	70-	80	Average .55.
Medium wrappers,	.	.	45-	55	
Dark wrappers,	.	.	35-	45	
Fall and Winter, 1917: —					
Light wrappers,	.	.	1 00-	1 25	Average .75 for light, medium and dark; average .585 for light, medium, dark, seconds and brokens.
Medium wrappers,	.	.	60-	70	
Dark wrappers,	.	.	40-	55	
Seconds,	.	.	35-	45	
Brokens,	.	.	25-	30	
Spring of 1918: —					
Light wrappers,	.	.	1 25-	1 35	Average .90 for light, medium and dark; average .705 for light, medium, dark, seconds and brokens.
Medium wrappers,	.	.	70-	80	
Dark wrappers,	.	.	60-	70	
Seconds,	.	.	45-	55	
Brokens,	.	.	30-	35	

The above table shows clearly the rise in the wholesale prices of Havana seed and broadleaf tobacco from 1915 to 1918. The 1918 prices were just double those of 1915-16, yet the price to the farmer increased only 51 per cent, being about 40 per cent more than the price in 1916. The farmer sold his tobacco at from 25 to 30 cents a pound, and this same tobacco, deducting the loss in sweating and shrinkage, and 11 cents per pound for packing, making the cost to the dealer 43 to 48 cents a pound, was sold to the manufacturer for an average of 71 cents for all grades.

Sun-grown Tobacco: Analysis of "Spread," Grower to Manufacturer.

The table below gives the cost of marketing a pound of tobacco from the farmer to the manufacturer. Most of the tobacco is sold by the packer, or, theoretically, by the dealer whom the packer represents, directly to the manufacturer. This table shows the profits when sold by the dealer directly to the manufacturer. The farmer whose cost of production was ascertained received in 1917-18, for tobacco in the bundle, 29 cents a pound. It cost the landowner 23.7 cents and the tenant 26 cents per pound to produce the tobacco. The profit to the landowner was 5.3 cents and to

the tenant 3 cents per pound. The dealer's cost of packing and selling, including the packer's salary and commission for buying, was 12 cents per pound. Adding to this the 29 cents paid the farmer we have a total cost to the dealer of 41 cents per pound. The average price received by the dealer per pound of tobacco was 71 cents. Hence the dealer's "profit" was 30 cents a pound. Naturally this situation cannot be continued indefinitely. These were war years. Moreover, there were many variations.

TABLE 39. — *Sun-grown Tobacco, 1917. Estimated Average Cost and Spread per Pound, Grower to Manufacturer.*

	Land-owner.	Tenant.	Percentage of Farm Price.		Percentage of Manufacturer's Cost.	
Farmer: —			Land-owner.	Tenant.	Land-owner.	Tenant.
Cost of production, ...	\$0.237	\$0.26	81.7	89.7	33.2	36.4
Farmer's margin, ...	.053	.03	18.3	10.3	7.4	4.2
Farmer's selling price, ...	\$0.290	\$0.29	100.0		40.6	
Dealer: —						
Salary of packer and buying commission, ...	.0067	.0067	2.4		1.0	
Cost of packing and selling, ...	.1130	.1130	39.0		15.8	
Dealer's margin over costs, ...	.3000	.3000	103.5		42.0	
Dealer's selling price: —						
60 per cent of crop at 90 cents per pound.	Average,	.71	244.9		99.4	
25 per cent of crop at 50 cents per pound.						
15 per cent of crop at 33 cents per pound.						
Broker's commission \$1.50 per case, ...	.004	.004	1.4		.6	
Manufacturer pays, ...	.714	.714	246.3		100.0	

In the last analysis each tobacco handler pays his expenses and takes his profits out of the tobacco he handles. If we think of these items being paid in tobacco rather than in money the above facts may be presented from a different point of view. The farmer delivers to the local packer a case of tobacco of 350 pounds. The local packer or dealer takes the equivalent of 203 pounds, which represents the cost of packing, sweating, shrinkage, storage, transportation and other expenses from the time the tobacco reaches his hands until he receives his final check. The amount delivered to the wholesale distributor is 147 pounds. The wholesale distributor takes 30 pounds of the 147, so that the manufacturer receives only 117 pounds. The difference between 350 and 117 pounds, or 233 pounds, represents the cost of marketing tobacco in its natural or unmanufactured state. In other words, the manufacturer pays as much for 117 pounds as

the grower receives for 350 pounds. The wholesale distributor is included in the chain of middlemen because he handles a considerable amount of tobacco.

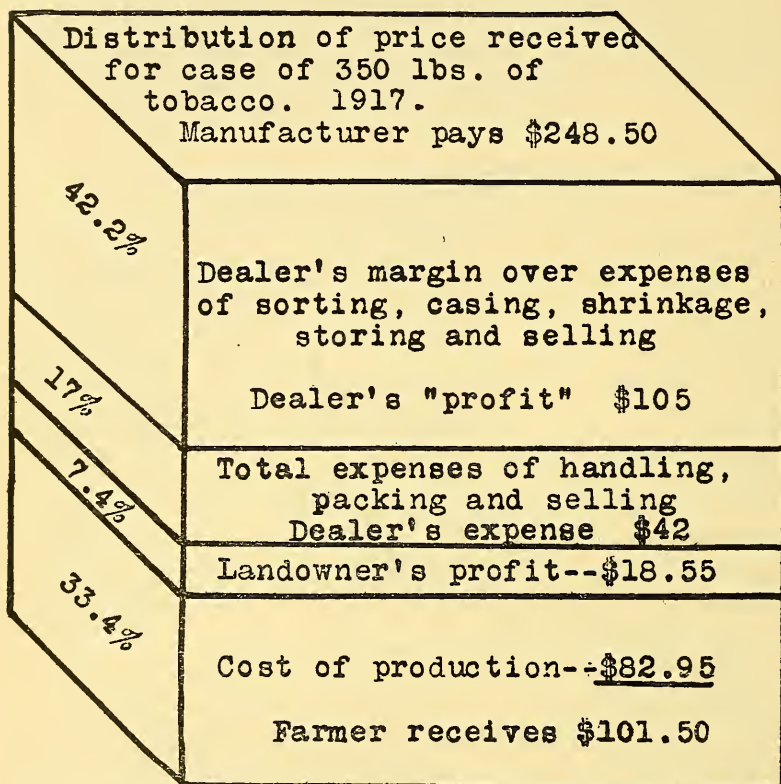


FIG. 19.—Sun-grown tobacco. Analysis of spread between grower and manufacturer on case of 350 pounds, 1917. Needless to say the figures are assumptions based on averages.

Farmers' Prices for Shade-grown Tobacco.

The shade-grown industry is peculiar in that the crop is largely produced by large syndicates and manufacturers. The American Sumatra Company has 1,500 acres in shade tobacco in Connecticut and Massachusetts. This company raises its own tobacco, sorts, packs and sells directly to manufacturers. The same is true of practically all the large syndicates. As previously stated, tobacco grown on contract by the farmer in 1917 ranged from 75 cents to \$1.10 in the bundle, with the bulk at 85 cents. The range for the previous years was from 60 to 80 cents a pound, with the average at about 70 cents.

Wholesale Prices for Shade-grown Tobacco.

The wholesale prices of shade-grown tobacco from 1915 to 1917 reported by the Tobacco Merchants' Association, and secured through a personal interview with the tobacco manufacturers, are given in the following list: —

	Per Pound.
Finest grade, 1915 crop, ...	\$2 00 to \$2 75
Finest grade, 1916 crop, ...	2 00 to 3 00
Light to medium, 1916 crop, ...	75
Medium bright, 1916 crop, ...	1 00
Fancy medium brown, 1916 crop, ...	1 15
Finest grade, 1917 crop, ...	3 75
Fancy medium brown, 1917 crop, ...	3 50
Medium bright, 1917 crop, ...	3 00
Light to medium, 1917 crop, ...	2 00
Extra fine, light color, 1917 crop, ...	1 75
Fine, medium to light, 1917 crop, ...	1 50

It is difficult for the farmer who raises shade tobacco on contract at the present time to make any profit. The cost of production for 1916 has been estimated at 75 cents a pound for the man with an established business, and \$1 a pound for the beginner. The large syndicates who raise, sort and pack their own tobacco and sell it directly to the manufacturer secure for themselves all profits between the producer and manufacturer, with an especially big profit on the shade-grown. But the large claims of clearing from \$1 to \$1.50 per pound on shade tobacco must be taken with some qualifications. The high cost of cloth, labor and supplies cuts deeply into the profits by greatly increasing the cost. On tobacco contracted by the farmer for from 65 cents to \$1 a pound the dealer now clears about \$1,000 per acre.

During 1917 Sumatra cost the manufacturer from \$6 to \$7 a pound, after adding the duty of \$1.85 a pound. The large manufacturers claim that the Connecticut shade-grown is equally good, if not better, for wrapper purposes than the imported Sumatra.

Co-operation in Marketing Tobacco.

The Connecticut valley produces a wrapper leaf of superior quality, but so long as the method of sale by contract prevails, wastes and abuses are sure to occur. The only way whereby farmers will be able to realize a fair profit from their crop is through some form of co-operation, and few industries are so well adapted to co-operative organization as the tobacco industry. The acreage is large and fairly unified, making organization rather easy. Yet up to 1917 nothing had been done along this line in the Connecticut valley, and very little has been accomplished in other states. In the South tobacco is sold by auction, and uniform warehouse receipts are issued to the farmers. This method of sale has been very satisfactory, each farmer's crop being sold on its merits. The warehouse receipts enable

the farmers to borrow money from any national bank to tide them over during the growing season.

There are 53 tobacco associations in the United States, 21 of which are in the State of Kentucky, 8 in Connecticut, 7 in Ohio, 5 in North Carolina, 5 in Virginia and 2 in Massachusetts. Of the 49 tobacco associations from which information was obtained as to the type of organization, only 17 are co-operative, the other 32 being joint stock companies.

Of the strictly co-operative associations 8 are in Connecticut, and 2 each in Massachusetts, Virginia and Kentucky. One of the Connecticut organizations has been in existence for some time, but the other 7 were organized very recently, the crop of 1918 being the first handled co-operatively.

The tobacco growers of the Massachusetts districts discussed the question of organization for some time, but no organizations were effected till the early part of 1919. Two associations are now in operation, one in the Hampden district and one in the Hatfield district. The matter is still under consideration in the Sunderland district, no association having as yet been formed.

These organizations control about 20 per cent of the total tobacco acreage of the Connecticut valley, and it is predicted that this proportion will soon be considerably increased.

The by-laws of one of these organizations are given in Appendix I.

The various co-operative associations of the tobacco growers of the Connecticut valley are federated into what is known as The Connecticut Valley Tobacco Growers, Incorporated, with headquarters in Hartford, Conn. The purposes of this federation are to supply an efficient selling agency for the member associations, to widen and improve the market for Connecticut valley tobacco, to establish uniform grades, to assist its members in standardization of the product, and to act as agent for the members in the purchase of supplies.

The by-laws of The Connecticut Valley Tobacco Growers, Incorporated, appear as Appendix II.

The warehouses of the 7 co-operative associations in Ohio are capitalized at \$10,000 each, with twenty-five to seventy-five stockholders. Each handles the tobacco of from 150 to 200 growers, representing from 250,000 to 300,000 pounds per year. The best system in operation is probably that at Covington, Ky. In this company thirty-five stockholders own the building. These men pay no dues for having their tobacco worked, and dividends amounting merely to the interest are paid. In addition there are 150 members of the company who pay dues of \$2 per year and a commission of 1½ cents per pound for having their tobacco worked. All patrons must be members of the Cigar Leaf Growers' Union. The company claims to have raised the price to the growers 2 cents per pound in normal years without any appreciable increase in the market price. The manager is bonded at \$3,000. The growers are paid when the tobacco is sold. At the Troy warehouse one-half of the amount due is advanced at a discount of 7 per cent.

TABLE 40. — *Number of Tobacco-selling Associations in the United States, classified by States and Type.*¹

STATE.	NUMBER OF TOBACCO ASSOCIATIONS.			Total.
	Co-operative.	Joint-stock.	Unknown.	
Massachusetts, ...	2	—	—	2
Connecticut, ...	8	—	—	8
Virginia, ...	2	3	—	5
North Carolina, ...	1	3	1	5
Ohio, ...	—	7	—	7
Kentucky, ...	2	17	2	21
Other States, ...	2	2	1	5
Totals, ...	17	32	4	53

¹ Data for states outside of the Connecticut valley from United States Department of Agriculture Bulletin No. 547.

RECOMMENDATIONS.

After a careful study of the tobacco industry in the valley, the following recommendations are offered: —

1. There should be in the hands of the farmers more general and definite information concerning the production (acreage, condition and yields) of tobacco. Farmers need to know the condition of the cigar leaf crop in all the cigar leaf producing states.

2. The grower should have more exact information on market conditions and prices to guide him in selling his crop.

3. A government reporter should be stationed in the valley to report weekly on the condition of the market and the prices. A weekly news letter should be sent to each tobacco farmer and dealer in the valley. This information should also be published in the newspapers.

4. Some improvements in sales methods are needed whereby the crop can be sold on its merits. The contract method of sale is fair neither to the buyer nor to the grower. The tobacco is sold while it is growing, or before it is planted, and no one can predict with certainty the quality of the crop. It is simply a gamble; the buyer gambles for the growers' crop, and he sets the price low enough to safeguard himself from loss.

Tobacco should be handled co-operatively by farmers, as described on page 213. This would permit each crop to be sold on its merits, and would eliminate some useless middlemen.

5. Farmers should be encouraged to keep cost accounts of production. Not one farmer in a hundred knows what it costs him to grow a crop of tobacco.

6. Every tobacco grower in the valley should take at least one good tobacco journal. The following journals are satisfactory: "The Tobacco

Leaf," published in New York, "The United States Tobacco Journal," published in New York, and "The Western Tobacco Journal," published in Cincinnati.

7. The tobacco growers should make more use of the various agencies which are in a position to assist them in producing and marketing their product, such as: —

(1) The United States Department of Agriculture, Washington, D. C. This office has tobacco specialists who will gladly assist in testing soils and furnishing information on the production of tobacco, and control of diseases and pests. This department publishes from time to time bulletins which the farmer should have, and which will be furnished free of charge.

(2) The Massachusetts Department of Agriculture, State House, Boston, Mass. This Department is interested in the production of farm crops in the state, and will gladly assist any farmer to obtain information concerning legislation and regulations dealing with diseases, pests, soils, fertilizers, etc. This information will be furnished from headquarters through reports, bulletins or correspondence.

(3) The Massachusetts Agricultural College, Amherst, Mass. The Agricultural Experiment Station and the Extension Service will assist growers in the production, handling and marketing of their crops. The Experiment Station has a tobacco specialist who is aiding the farmers in many ways along lines of production, soil and plant diseases, fertilizers, cover crops and the like. From the Extension Service a specialist on marketing and farmers' co-operative organizations will furnish information on marketing or assist in organizing farmers' co-operative purchasing and selling associations.

(4) The county farm bureaus. Each county has a farm bureau, working in co-operation with the United States Department of Agriculture and the Massachusetts Agricultural College, which is interested in the production and marketing of farm crops within the county. These bureaus will gladly aid individual tobacco growers in methods of production and handling their crops. Such information will be furnished by correspondence, personal interviews, demonstrations or reports.

BIBLIOGRAPHY.

- ANDREWS, FRANK. Costs of hauling Crops from Farms to Shipping Points. U. S. D. A., Bur. Stat. Bul. 49, 1907.
- BACHE, RENÉ. The Great Tobacco Strike. In *Technical World*, Vol. VI, No. 6, February, 1907.
- BILLINGS, E. R. Tobacco. Its History, Varieties, Culture, Manufacture and Commerce. Hartford, Conn., 1875.
- BOHANNAN, C. D., and CAMPBELL, D. P. A Preliminary Study of the Marketing of Burley Tobacco in Central Kentucky. Ky. Agr. Exp. Sta. Bul. 202, 1916.
- BRENNAN, W. A. Tobacco leaves. Menasha, Wis., 1915.
- CLAY, GREEN. What I learned selling Tobacco. In *Country Gentleman*, Vol. 76, No. 3061, Sept. 28, 1911.

- FIPPIN, E. O. Soil Survey of the Connecticut Valley. Washington, 1903.
- FREAR, W., and HIBSHMAN, E. K. Cost of Production of Lancaster County Filler Tobaccos. Annual report of the Pennsylvania State College for the year 1908-09. Pa. Agr. Exp. Sta., 1909.
- FREEMAN, W. G., and CHANDLER, S. E. The World's Commercial Products. London, 1907.
- GARNER, W. W. The Present Status of the Tobacco Industry. U. S. D. A., Bur. Plant Indus., Cir. 48, 1910.
- GARNER, W. W. Tobacco Culture. U. S. D. A., Farmers' Bul. 571, 1914.
- GARNER, W. W. Tobacco Curing. U. S. D. A., Farmers' Bul. 523, 1913.
- GILMORE, E. H. History of Tobacco. Washington, 1878.
- Harvesting and curing the Tobacco Crop. The Farmer. March 6, 1915.
- HUEBNER, G. G. Agricultural Commerce; The Organization of American Commerce in Agricultural Commodities. New York, 1915.
- The Infant Tobacco Industry of Minnesota. The Farmer. Jan. 23, 1915.
- JACOBSTEIN, MEYER. The Tobacco Industry in the United States. Columbia University Studies in History, Economics and Public Law, Vol. XXVI, No. 3, 1907.
- JENKINS, E. H. Studies on the Tobacco Crop of Connecticut. Conn. Agr. Exp. Sta. Bul. 180, 1914.
- KILLEBREW, J. P. Tobacco Districts and Types. U. S. D. A., Bur. Stat., Cir. 18, 1909.
- KILLEBREW, J. P. Tobacco Report, July 1, 1911. U. S. D. A., Cir. 22, 1911.
- KILLEBREW, J. P., and MYRICK, HERBERT. Tobacco Leaf: Its Culture and Cure, Marketing and Manufacture. New York, 1897.
- LOCK, C. G. W. Tobacco: Growing, Curing and Manufacturing. New York, 1886.
- LOEW, OSCAR. Curing and Fermentation of Cigar Leaf Tobacco. U. S. D. A., Report 59, 1899.
- MCNESS, G. T., MATHEWSON, E. H., and ANDERSON, B. G. The Improvement of Fire-cured Tobacco. Va. Agr. Exp. Sta., Bul. 166, 1907.
- MCNESS, G. T., MATHEWSON, E. H., and ANDERSON, B. G. The Improvement of Virginia Fire-cured Tobacco. U. S. D. A., Bur. Soils, Bul. 46, 1907.
- Massachusetts Bureau of Statistics of Labor. Census of the Commonwealth of Massachusetts.
- MATHEWS, J. L. Agrarian Pooling in Kentucky. In Charities and the Commons, Vol. 20, May 2, 1908.
- MATHEWS, J. L. The Farmers' Union and the Tobacco Pool. In Atlantic Monthly, Vol. 102, p. 482, October, 1908.
- MATHEWSON, E. H. The Culture of Flue-cured Tobacco. U. S. D. A., Bul. 16, 1913.
- MATHEWSON, E. H. The Export and Manufacturing Tobaccos of the United States, with Brief Reference to Cigar Types. U. S. D. A., Bur. Plant Indus., Bul. 244, 1912.
- MATHEWSON, E. H. Summary of Ten Years' Experiments with Tobacco. Va. Agr. Exp. Sta., Bul. 205, 1914.
- MATHEWSON, E. H. Tobacco Marketing in the United States. U. S. D. A., Bur. Plant Indus., Bul. 268, 1913.
- MATHEWSON, E. H. Work at the Tobacco Stations. Va. Agr. Exp. Sta., Bul. 183, 1909.
- MATHEWSON, E. H., ANDERSON, B. G., and COCKE, R. P. Co-operative Tobacco Investigations. Va. Agr. Exp. Sta., Bul. 175, 1908.
- New England Homestead. Springfield, Mass.
- New England Tobacco Grower. Vols. 1-8, March, 1902, to December, 1905. Hartford, Conn.
- New York Chamber of Commerce. Annual reports. New York.

- ODLUM, G. M. *The Culture of Tobacco*. Dept. Agr., Salisbury, Southern Rhodesia. London, 1905.
- SCHERFFIUS, W. H., and WOOSLEY, H. *Tobacco: 1. Cultivation; 2. Curing; 3. Marketing*. Ky. Agr. Exp. Sta. Bul. 139, 1909.
- SINGER, C. *The Early History of Tobacco*. In *Quarterly Review*, August, 1913.
- SMITH, J. R. *Industrial and Commercial Geography*. New York, 1913.
- TAEUSCH, C. F. *Rural Co-operation and Co-operative Marketing in Ohio*, 1913. Ohio Agr. Exp. Sta., Cir. 141, 1913.
- TANNER, A. E. *Tobacco from the Grower to the Smoker*. New York, 1912.
- Tobacco culture; prize essays*. American Agriculturist, New York.
- Tobacco Leaf*. New York.
- United States Bureau of Corporations. *Report on the Tobacco Industry*. Part I, *Position of the Tobacco Combination in the Industry*, 1909; Part II, *Capitalization, Investment and Earnings*, 1911; Part III, *Prices, Costs and Profits*, 1915.
- United States Bureau of Foreign and Domestic Commerce. Department of Commerce and Labor. *Special consular reports*.
- United States Commissioner of Internal Revenue. *Annual reports*.
- United States Department of Agriculture. *Monthly crop reporter*.
- United States Department of Agriculture. *Tobacco crop of the United States, 1612-1911*. Cir. 33, 1912.
- United States Department of Agriculture. *Yearbook*. Appendix. 1915, 1916.
- United States Department of Commerce. Bureau of the Census. *Reports*. 1880, 1890, 1900, 1910.
- United States Department of Commerce. Bureau of the Census. *Stocks of leaf tobacco*. 1917. Bul. 136, 1918.
- United States Department of Commerce and Labor. *Statistical abstract*, 1916.
- United States Tobacco Journal. New York.
- WERNER, CARL, *A Textbook on Tobacco*. New York, 1914.
- Western Tobacco Journal*. Cincinnati, Ohio.
- WHITNEY, MILTON. *Growing Sumatra Tobacco under Shade in the Connecticut Valley*. U. S. D. A., Bur. Soils, Bul. 20, 1902.
- WHITNEY, MILTON. *Methods of curing Tobacco*. U. S. D. A., Farmers' Bul. 60. 2d rev. ed. 1902.
- WHITNEY, MILTON. *Tobacco Soils of the United States: A Preliminary Report upon the Soils of the Principal Tobacco Districts*. U. S. D. A., Div. Soils, Bul. 11, 1898.
- WHITNEY, MILTON, and FLOYD, M. L. *Growth of the Tobacco Industry*. U. S. D. A., Yearbook, 1899.

APPENDIX I.

BY-LAWS OF THE HAMPSHIRE COUNTY TOBACCO GROWERS,
INCORPORATED.

ARTICLE I.

Name and Membership.

SECTION 1. The name of this corporation shall be the Hampshire County Tobacco Growers', Incorporated. Its principal office shall be located at Hadley, Mass.

SECTION 2. The voting membership of this corporation shall be confined to persons actually engaged in tobacco production at points tributary to the shipping stations of the corporation, who sell their products through the corporation, who have been approved as eligible candidates for membership by a majority vote of the directors, and who have paid their membership fees in full and agreed to conform to the provisions of the by-laws. No one who in the opinion of the directors is a professional buyer of tobacco shall be eligible to membership.

SECTION 3. Any member who in the opinion of the board of directors ceases to be a producer shall be dropped by a majority vote of the directors, but such action shall not invalidate any legitimate charges or accounts which the corporation has against the member so dropped. Such charges shall be a lien on any funds due the member from the corporation and on any loan notes required of the member by the by-laws of the corporation. A member dropped in this manner shall forthwith lose voting privilege in the corporation.

SECTION 4. Any member who violates his contract with the corporation may be expelled from membership in the corporation by a two-thirds majority vote of those present at any regular called meeting of the corporation, provided that notice of such proposed action was mailed to the person so dropped at least five days before date of such meeting, and provided that opportunity was given to the accused member to defend himself personally or by counsel and witnesses before such vote is taken. The financial conditions set forth in the preceding paragraph shall also apply in the case of a member expelled from the corporation.

ARTICLE II.

Purposes.

SECTION 1. The purposes of this corporation shall be to produce, sort, grade, pack, manufacture, sell, transport, store, market and otherwise handle for sale tobacco and other farm products; to secure and employ

laborers and supervise labor contracts and conditions in the growing territory covered by this corporation; to own, lease, buy, build and otherwise acquire title to buildings, machinery and other property; to hold, use and operate the same for any lawful purpose; to buy, sell, transport, store, manufacture or otherwise deal or trade in food products, agricultural products or requirements, or any other products, animals, goods, articles or materials; to acquire any other rights, engage in any business, perform any other lawful acts or take any measures that the corporation may deem advisable for the purposes of protecting the property of the corporation or carrying into effect the foregoing purposes or furthering the interests of agriculture or country life.

ARTICLE III.

Board of Directors and Other Officers.

SECTION 1. The board of directors of this corporation shall consist of seven members divided into three classes. They shall be chosen by ballot by majority vote of those present and voting at the regular annual meeting of the corporation. At their first meeting the members shall elect three directors of the first class for a term of one year, or until next annual meeting; two directors of the second class for a term of two years, or until the second annual meeting; and two directors of the third class for a term of three years, or until the third annual meeting. At the expiration of the terms of the directors so elected their successors shall be chosen in like manner for terms of three years. Directors shall hold office until their successors have been elected and qualified.

SECTION 2. Within ten days following their election, and each annual election, the board of directors shall meet and elect by ballot from their own number a president and vice-president, whose terms shall be for one year. The board of directors may also appoint a manager, who may be the clerk or treasurer of the corporation.

SECTION 3. Four members of the board of directors shall constitute a quorum to do business at any meeting of the board.

SECTION 4. The other officers shall be a clerk, a treasurer, and a committee of audit of three members. They shall be elected by ballot at the annual election by the qualified voters from their own number. They shall hold office for one year and until their successors have been elected and qualified.

SECTION 5. Any director or officer of the corporation may, for cause, at any annual meeting or at any special meeting called for the purpose, at which a majority of the members shall be present, be removed from office by vote of not less than two-thirds of the members present. Such director or officer shall be informed in writing of the charges at least five (5) days before such meeting, and at such meeting shall have an opportunity to be heard in person, by counsel, and by witnesses, in regard thereto.

ARTICLE IV.

Vacancies.

SECTION 1. If a vacancy occur in the board of directors, it shall be the duty of the president to call a special meeting of the corporation to fill such vacancy, and such director shall hold office until his successor is elected and qualified.

SECTION 2. Other vacancies shall be filled by the directors at their first meeting after such vacancy occurs.

ARTICLE V.

Meetings.

SECTION 1. The annual meeting of the members of this corporation shall be held in Hadley, Mass., at a place designated by the board of directors, on the second Wednesday in April, at 11 o'clock A.M.

SECTION 2. One-fifth of the voting members shall constitute a quorum to do business at the annual or any special meeting.

SECTION 3. At the annual meeting reports shall be presented in writing by the board of directors, the regular officers, manager, the committee of audit, and other committees; directors, a clerk, a treasurer and a committee of audit shall be elected for the ensuing year. Such other business as may properly come before the meeting shall be transacted.

SECTION 4. Special meetings of the corporation may be called by the president or board of directors, and shall be called within seven days from receipt of written petition of seven members. The president shall give the members written notice of all annual or special meetings at least seven days previous to the date of such meeting, stating the purpose for which the meeting is called.

SECTION 5. The directors shall hold regular meetings to consider the business of the corporation on the first Saturday of each month at Hadley, Mass. Special meetings of the board of directors shall be held on call of the president, or within seven days from receipt of written petition of three members of the board. The president shall give the members of the board four days' notice of such meetings. The directors shall receive no remuneration for their services except that the clerk and treasurer may receive such compensation as may be determined by the corporation.

SECTION 6. The fiscal year of this corporation shall begin April 1, and end the following March 31.

ARTICLE VI.

Duties of Officers.

SECTION 1. The president shall preside at all meetings of the directors or members of the corporation, call all meetings of the board of directors and special meetings of the corporation except as otherwise provided, preserve order, sign all orders regularly passed by the board of directors and

attested by the clerk or manager, and perform all other duties appertaining to his office, or any other assigned him by the corporation. The president shall have no vote at any meeting except in case of tie.

SECTION 2. It shall be the duty of the vice-president to perform the duties of the president in his absence, or when for any reason the office of president may become vacant.

SECTION 3. The clerk shall keep a record of the proceedings of all meetings of the members and of the directors. He shall keep the corporate seal of the corporation and shall be custodian of all books, papers and other valuable instruments belonging to the organization. He shall keep all books of the issuance and withdrawal of certificates of membership and affix the seal of the corporation; he shall serve all notices and make all reports required by law or by the by-laws, and perform such other duties as may be required of him by the corporation or the board of directors.

SECTION 4. The treasurer shall receive all money due or paid to the corporation and deposit it as the directors may instruct; and pay out said funds upon his own order, countersigned by the president. He shall make full and detailed report of the financial condition of the corporation at the annual meeting of each year, and at such other times as called upon by vote of the members. He shall give bond in a sum and form to be approved by the board of directors, for the faithful performance of his duties and as surety for the funds, books, papers and other instruments of the corporation which may be placed in his custody. The cost of such bond may be borne by the corporation.

SECTION 5. The directors shall have general control and direction of the business and affairs of the corporation; they shall make all necessary rules and regulations for the management of the corporation and the guidance of the officers and employees; they shall perform all duties assigned them by the by-laws of the corporation. The directors may, by a majority vote, appoint or discharge any employee of the corporation, determine the duties of officers and employees, and fix their compensation, except as limited by the members. The directors may delegate the employment or discharge of laborers, agents or other employees to the manager.

SECTION 6. The manager shall have entire charge of the marketing and handling of the products of the corporation, of purchases made by the corporation for the members, and of the daily business transactions of the corporation subject to the oversight and supervision of the board of directors and the provisions of the by-laws and the growers' contracts. He shall have charge of the grading, packing, inspection, marketing, labeling and advertising of the products handled by the corporation. He shall supervise the making and execution of labor and crop contracts, and shall enforce their provisions. He shall assist in securing and furnishing to the members such market and crop information as they may desire concerning the products marketed by the corporation, and shall perform such other duties as the corporation or its directors may require. He shall attend the meetings of the board of directors and shall have the same right to

originate and propose motions and amendments and to participate in deliberations as a director, but he shall have no vote in that body.

All payments over \$5 made by the manager for purchases and general expenses shall be made by check signed by him and countersigned by the treasurer. He shall keep permanent record of all his business transactions.

The manager shall be required to give bond in a sum and form to be approved by the board of directors for the faithful performance of his duties, and as surety for the funds and property of the corporation which may be placed in his custody. The cost of such bond may be borne by the corporation.

ARTICLE VII.

Committee of Audit and Accounts.

SECTION 1. A committee of audit, consisting of three members, shall be elected by ballot at the annual meeting of the corporation. Officers and directors of the corporation shall be ineligible to membership on said committee.

SECTION 2. It shall be the duty of the committee of audit to examine and audit the books of the corporation at least twice a year, to report their findings to the board of directors, and to examine and audit the books, and report at such other times as may be ordered by the directors or by vote of the corporation. An audit by a competent accountant shall be made prior to each annual meeting and presented in detail at that meeting.

SECTION 3. The corporation shall install an adequate system of accounts and provide such accounting equipment as may be necessary to conduct the business in a safe and satisfactory manner.

ARTICLE VIII.

Membership Certificates and Fees.

SECTION 1. Upon entering the corporation and paying its membership fee the corporation shall issue to each member a certificate of membership signed by the secretary and countersigned by the president. Certificates of membership shall not be transferable.

SECTION 2. Each member shall pay in advance to the corporation a membership fee, and annual dues determined by the board of directors.

SECTION 3. Any member may withdraw from the corporation at any time between the first day of February and the first day of April following, provided that his indebtedness to the corporation is fully paid. Such withdrawal shall not affect any right or any lien which the corporation has against such member or his property.

SECTION 4. Any member, having a grievance or complaint against the corporation, may appeal to the board of directors or to the members at any regular or special meeting. No member shall be suspended or expelled or deprived of the benefits of the corporation without first having charges preferred against him, reasonable notice thereof having been given, and a hearing before the board of directors having been duly held.

ARTICLE IX.

Funds and Indebtedness.

SECTION 1. All funds belonging to this corporation shall be deposited in a bank or banks designated for the purpose by the board of directors.

SECTION 2. The amount of indebtedness which may be incurred by or on behalf of this corporation shall at no time exceed \$50,000.

SECTION 3. The expenses of operating the corporation shall be met by a uniform percentage charge laid upon returns for produce sold or by a uniform fixed commission per package, and by a percentage charge upon supplies purchased, the amount of such charge to be fixed by the board of directors.

ARTICLE X.

Supplies.

SECTION 1. Merchandise or supplies may be ordered through the corporation by the members, and all business so transacted shall be conducted on a cash basis or on credit arranged for through some bank approved by the board of directors at the date of ordering.

SECTION 2. Supplies shall be sold to members of the corporation at prices determined by the board of directors.

ARTICLE XI.

Voting and Earnings.

SECTION 1. The voting membership of the corporation shall consist of those members who have paid in full their dues and fees and have satisfied any other obligations due the corporation and who have signed growers' contracts for the current year. Other persons who have paid their membership fees and dues, but who have not signed contracts for the current season, may retain their membership in the organization, but shall have no vote.

SECTION 2. Each member of the corporation shall have one vote and one only. Proxy voting shall not be permitted.

SECTION 3. The net receipts accruing from the business of the corporation shall be distributed on the pro rata basis of business of the members transacted through the corporation.

ARTICLE XII.

Capital.

SECTION 1. In order to provide capital for current needs and for the transaction of the necessary business of the corporation each member shall deliver to the corporation a negotiable promissory note payable on demand to the order of the corporation. Such note shall be for the sum of \$50 and an additional \$10 for each acre of tobacco to be grown by the maker to be marketed through the corporation. In no case shall this note be for a sum

less than \$60. Such note may be given at the time of joining the corporation, or at any time thereafter when called upon by the board of directors.

SECTION 2. The board of directors may pledge these notes as collateral security for any loan that may be necessary for conducting the business of the corporation. The note of any member may be available in settlement of any liquidated damage that may result from the failure of a member to live up to his contract with the corporation.

SECTION 3. For the purpose of buying, leasing or constructing land, warehouses or other necessary buildings, or in providing machinery or equipment, the board of directors may require each member to loan to the corporation an amount, to be determined by the board but based on acreage of tobacco, not less than \$5 nor more than \$15 in cash per acre during one year. Such loans may be required at the time of uniting with the corporation or at any time thereafter. They shall draw interest at the rate of 5 per cent per annum.

Such loans shall be repaid from a special loan fund collected by levying a percentage assessment on the produce sold and the supplies bought through the exchange, the amount of such percentage to be fixed by the board of directors; but not more than one-fifth of the entire loan and interest thereon shall be paid in any one year.

ARTICLE XIII.

Contracts.

SECTION 1. Every member of the corporation shall enter into a contract with the corporation in the form required by the board of directors. Such contract shall provide that the member appoints the corporation his sales agent, to handle all products grown by him for sale or purchased for his use, or such part thereof as shall be satisfactory to the board of directors, and obligates himself to deliver such products for sale at the time and place which the corporation directs. Said contracts shall run continuously unless cancelled by the member on April 1 of any year by giving written notice to the corporation at least sixty days prior to said date that he desires to cancel his contract, subject to any indebtedness due from him to the corporation, and by delivering his copy of the contract to the corporation on or before April 1. Said canceling of contract shall not apply to the previous year's crop.

SECTION 2. On or before April 1 of each year each member shall report to the corporation the number of acres of products to be grown by him and to be marketed through the corporation. During the year each member shall furnish such information concerning the products pledged to the corporation as may be requested by the manager.

The directors may authorize increases or decreases in the acreage reported by any member, as required by this section.

SECTION 3. In case any member is offered a price in excess of the price then obtainable by the corporation, said member shall turn over such bid to the corporation for filling from said grower's goods.

SECTION 4. Any member who fails to fulfill his contract or fails or refuses to market his tobacco through the corporation shall pay to the corporation, as liquidated damages, the sum of 5 cents for each pound of tobacco grown by him; and such damages may be deducted from any money in the possession of the corporation due the member. Any such claim shall be a lien upon the member's loan note.

ARTICLE XIV.

Amendments.

These by-laws may be altered or amended by a two-thirds vote of the members present at any regular annual meeting or at any special meeting called for the purpose, provided that the subject-matter of such an amendment shall have been presented in writing at a previous regular or special meeting, or is included in the notice calling such a meeting.

APPENDIX II.

BY-LAWS OF THE CONNECTICUT VALLEY TOBACCO GROWERS, INCORPORATED.

(1) This association shall be known as The Connecticut Valley Tobacco Growers, Incorporated, duly organized under chapter 190, revision of 1918 of the general statutes relating to co-operative associations. Its principal office and place of business shall be located in the city of Hartford, State of Connecticut, and it shall do business in the States of Connecticut and Massachusetts and elsewhere.

(2) The nature of the business to be transacted and the purposes to be promoted or carried out by said corporation are as follows:—

To provide and maintain for its members a selling agency through which they may sell their tobacco and do all things or acts necessary or convenient to make such selling agency efficient in assisting its members in marketing said tobacco; to enlarge and improve the market for Connecticut valley tobacco, and to aid in supplying manufacturers and others with good tobacco at a reasonable price; to assist its members in standardizing, sorting, packing and warehousing their tobacco, and to encourage the improvement of the products which it handles, either by trade-marks, by trade names or otherwise; to act as agent for its members in the purchase of any supplies which they may require; and to do any other lawful things which may be for the benefit of the members.

(3) Any local co-operative tobacco growers' association located in this State or in the State of Massachusetts may acquire and hold stock in this association.

(4) Each local association holding stock in this association shall elect two of its members to represent it in this association. At the annual meeting of this association these representatives shall elect from their own number a president, vice-president, secretary and treasurer, who shall hold office for one year, or until their successors are duly elected and qualified. These representatives shall constitute the board of managers of this association.

(5) In order that this association may have necessary working capital at the beginning of any season, each local association owning the stock of this association shall advance to the treasurer of this association, not later than August 15 of any year, the sum of \$1 for each acre of tobacco represented by said local association.

(6) The capital stock which this association is authorized to issue is \$50,000, divided into 500 shares of the par value of \$100 each.

(7) SECTION 1. The annual meeting of this association shall be held at its office in Hartford on the third Saturday of July of each year. At this meeting officers shall be elected for the ensuing year; reports in writing presented by the president, treasurer and auditors; and such other business shall be transacted as may properly come before the meeting.

SECTION 2. Special meetings shall be held upon the call of the president, or within ten days of a written request of five members. Five days' notice of such meetings shall be given, and notices shall state the purpose for which said meeting is called.

SECTION 3. At all meetings a majority of the members shall constitute a quorum.

(8) The board of managers shall choose three auditors from among the members of the local associations owning stock in this association who are not directors, officers, agents or employees of this association. Such auditors shall hold office for one year, or until their successors are duly elected and qualified.

(9) Any vacancy in the offices of board of managers shall be filled for the unexpired term at any regular meeting or at any special meeting called for the purpose, in the manner provided for the original election of directors and officers.

(10) A majority of the members of the board of managers shall constitute a quorum at any meeting of the board.

(11) The board of managers shall manage the business affairs of the association, and make all necessary rules and regulations, not inconsistent with law or with these by-laws, for the management of the business and the guidance of the officers, employees and agents of the association.

(12) The board of managers may employ and dismiss for cause a general manager, and fix his compensation, who shall have charge of the business of the association under the direction of the board of managers. They may also employ and dismiss other employees and fix their compensation.

(13) The board of managers shall require the treasurer and all other officers, agents and employees, charged by the association with the responsibility for the custody of any of its funds or property, or to carry out any functions assigned them, to give bond with sufficient surety for the faithful performance of their official duties, the cost of said bonds to be paid by the association.

(14) The board of managers shall meet regularly once each month at the office of the association at a date and hour to be determined by them. Special meetings of the board shall be held upon the call of the president or upon written request of at least three members of the board. A majority of the members of the board shall constitute a quorum.

(15) It shall be the duty of the president to preside at all meetings of the association and of the board of managers; to sign, as president, with the treasurer, or in his absence, with the secretary, all checks, notes, deeds and other instruments in behalf of the association; to call special meetings of the association and of the board of managers, and perform all other acts and duties usually required of such officer.

(16) In the absence or disability of the president, the vice-president shall preside and perform the duties of the president.

(17) The secretary shall keep a complete record of all meetings of the association and of its board of directors; serve all notices required by law and by these by-laws; and keep a complete record of all business of the association, and make a full report of all matters and business pertaining to his office to the members at their annual meeting, and make all records required by law.

(18) The treasurer shall, with the president, sign all checks, notes, deeds and other instruments on behalf of the association; receive and disburse all funds and be the custodian of all property of the association; and perform such other duties as may be required of him by the association and the board of managers.

(19) Under the direction of the board of managers, the general manager shall employ and discharge all employees, agents and laborers. He shall secure information as to crop and market conditions, and shall furnish same to stockholders on request. He shall encourage the production of the best varieties of tobacco demanded by the trade. He shall, as may be required by the board of managers, provide a uniform system of assorting, grading and packing, and disseminate information regarding same among the local associations. He shall also provide and assist in installing uniform systems of accounting for the local associations. He shall inspect all products handled by the association, and shall prescribe the brands and labels of the association and their use of such products, in accordance with the rules of the association. Subject to the terms of the contracts made by the members with this association for the marketing of their products, and to the order of the board of managers and the by-laws and rules of this association, the general manager shall have charge of the sale and marketing of such products.

(20) All brands, labels, trade-marks and the like, established by this association for the protection of the products sold by it, shall be registered and become its property, and shall be attached only to such tobacco as shall be specified by the board of managers.

(21) Every local association owning the stock of this association shall enter into a contract with this association in the form to be agreed upon, subject, however, to the following provisions:—

(a) That said stockholder, by said contract, appoints The Connecticut Valley Tobacco Growers, Incorporated, its sales agent to sell its tobacco in such amount and condition and in such manner as the contract shall prescribe, and binds itself to deliver such products for sale at such time and place as this association directs.

(b) That said contract shall run continuously unless cancelled by either party on July 15 of any year, written notice having previously been given by one party to the other at least thirty days prior to that date, stating that it desires to cancel its contract; and subject to any indebtedness due from either party to the other. .

(22) Each stockholder shall have a number or mark which shall be permanently stamped on every case or other package packed by him, or under his direction, for sale through this association. Any loss occasioned by improper packing or grading shall be chargeable to the stockholder whose mark is found on said package.

(23) Tobacco packed by, or for, any stockholder shall be inspected by an inspector of this association to establish uniformity of grades.

(24) Any stockholder may withdraw from this association on the fifteenth day of July by giving written notice to the board of managers thirty days before said date, and by transferring his holdings to the association at their book value as shown by the last official report of the association, but at not less than the par value of the shares. Such withdrawal shall not affect any right of lien which the association has against the withdrawing member or his property until his indebtedness to the association is fully paid. Said transfer of shares shall be made only upon the books of this association.

(25) Any stockholder having a grievance or complaint against the association may appeal to the board of managers or to the members at any regular or at any special meeting. No member shall be suspended or expelled or deprived of the benefits of the association without first having charges preferred against him, reasonable notice thereof having been given and a hearing before the board of managers having been duly held.

(26) After a season's expenses are paid, a sum equal to 10 per cent of the net savings of the association for the past year shall be set aside for a contingent fund until there shall have been accumulated thereby a sum equal to 20 per cent of the capital stock of the association. The balance of the season's savings on products shall be divided among local associations holding the stock of this association in proportion to the amount or value of their products sold, and the balance of the season's savings purchased shall be divided in like manner.

(27) Any stockholder who fails to perform his agreement, or fails or refuses to market his tobacco through this association, as provided in his contract with this association, shall pay to this association, as liquidated damages, the sum of 2 cents for each pound of tobacco which he fails to deliver, and such damages may be deducted from any money in the possession of the association due the stockholder.

(28) The books and business of this association shall be audited quarterly by auditors selected, as aforesaid. A complete annual audit shall be made previous to the date of each annual meeting, at which meeting the auditor's report shall be presented in full. Special audits shall be made upon order of the board of managers, or upon a majority vote of the members at any regular or at any special meeting.

(29) These by-laws may be amended or repealed at any meeting by a two-thirds vote of the members present, provided that notice of such proposed amendment or repeal is included in the call for said meeting, and provided that such changes shall be approved by the local associations.

BULLETIN No. 194.

DEPARTMENT OF AGRICULTURE.

A FERTILIZER EXPERIMENT WITH ASPARAGUS.

DESCRIPTION OF THE EXPERIMENT.

F. W. MORSE.

The fertilizer experiment with asparagus reported in the following pages was planned and supervised by Dr. Wm. P. Brooks, then director of the Experiment Station. The experiment was conducted in the town of Concord, on land owned by C. W. Prescott, and arrangements were made with him to act as superintendent of the substation. The plans prepared by Dr. Brooks for the experiment were executed by Mr. Prescott throughout the entire period from 1906 to 1915. His interest in the work and his careful attention to all its details permitted the successful conduct of the substation and the satisfactory completion of the fertilizer comparisons. Valuable assistance was given each year by Prof. J. B. Norton of the United States Department of Agriculture, who was stationed at the field for the purpose of developing a rust-resistant type of asparagus, and who took an active interest in the fertilizer experiment. This description of the experiment has been prepared by the writer, who was engaged on chemical studies of the asparagus plant which gave opportunity for familiarity with the fertilizer comparisons, although he had no part in the planning and supervision of the experiment which were solely the work of Dr. Brooks.

The land selected for the experiment lies on Bedford Street in the town of Concord.¹ For a number of years prior to its selection the field had lain fallow, and was overgrown with weeds, blackberry vines and small birches. It was considered to be typical of the fields used for asparagus culture in the vicinity, where the crop is largely grown, and the soil was deemed to contain only the natural store of fertility.

¹ Mass. Agr. Expt. Sta., 20th Ann. Rept., p. 16.

The field is part of a sandy plain in the area drained by the Concord River, a tributary of the Merrimac, and its soils would probably be classed with the Merrimac Series described by the United States Bureau of Soils.¹ It consists of a coarse, sandy loam about 2 feet in depth, underlaid by several feet of sand and gravel, as shown by a railroad cut about 200 yards distant from the plots.

The land was cleared of bushes, and in May, 1906, it was plowed, the soil being turned over to a depth of 8 to 9 inches. The field was repeatedly harrowed with a disc harrow to pulverize the turf and kill the weeds. Late in June an application of fertilizers was made to each acre, consisting of —

	Pounds.
Fine ground bone, ...	1,000
Acid phosphate, ...	600
Muriate of potash, ...	350
Nitrate of soda, ...	150

The fertilizers were thoroughly mixed with the soil by the harrow. About two weeks later 2,000 pounds of agricultural lime per acre were applied and harrowed in.

Just after the middle of July buckwheat was sown. The crop made a vigorous growth and reached a height of 36 to 42 inches when in full bloom, about the third week in September, at which time it was plowed under. After harrowing the field it was sown with winter rye and rolled, which completed the work on the field for the year.

In April, 1907, the rye was plowed under, the field was harrowed and rolled, and then laid out in plots for the experiment.

Forty plots of one-twentieth acre each were arranged in two parallel groups of 20 plots. Each one measured 129 feet in length by 16 feet, 10.5 inches in width, and was separated from the adjacent plots by division strips which measured 5 feet, 1.5 inches in width. Each plot contained five rows of plants which were set 30 inches apart in the row, thus permitting 250 plants per plot, or 5,000 per acre. Each division strip also had a row of plants through the center, by which arrangement all rows on the plots were under closely similar conditions of space and light for their development.

The plants were grown by Mr. Frank Wheeler of Concord from a strain of Giant Argenteuil which had been selected by him for its vigorous growth and resistance to rust. They were one year old and exceptionally large and strong. The crowns were placed in the furrows at a depth of 6 inches below the level surface of the field. After the plants were set the first lot of fertilizers prescribed by the experiment for each plot was applied. The description of these fertilizers will be given later when the results of the experiment are considered.

Practically all the plants lived and made a vigorous start. Their growth throughout the season was strong, and numerous stalks attained

¹ U. S. Dept. Agr., Bur. of Soils, 8th Rept. (1906), pp. 57-63; Bul. No. 55 (1909), p. 158.

a height of 6 feet before growth ceased for the season. Beetles were numerous, but were held in check by spraying with arsenical insecticides, lead arsenate proving most satisfactory.

In September oats were sown as a cover crop, which made a good growth before winter set in. Before the buds started in the spring of 1908, as soon as the soil could be worked, the dead tops and cover of oats were worked into the soil with the disc harrow, and the prescribed fertilizers were applied to the different plots. The young shoots were of such size and appearance that Mr. Prescott made three cuttings in early May, and though the roots were but two years old from the seed, some stalks were an inch in diameter.

It was noted that the violent spring winds seriously affected some of the plots by blowing the sharp sand against the young shoots. To prevent this a windbreak of cotton cloth tacked to posts was maintained during the early part of the season while the stalks were tender. The field was kept free from weeds by summer tillage, and the beetles were held in check by a lead arsenate spray. The growth of the plants was excellent, and the tops at the end of the season nearly filled the spaces between rows.

In the succeeding years of the experiment the culture and fertilization were conducted in general as in 1908.

The cutting season in 1909 lasted about four weeks, but in subsequent years the stalks were harvested each season for about two months. The limits of the cutting season for each year were as follows:—

1909, May 7 to June 6.
 1910, April 23 to June 29.
 1911, May 8 to June 24.
 1912, May 5 to June 25.
 1913, April 27 to June 27.
 1914, May 8 to June 27.
 1915, April 26 to June 26.

In the summer of 1910 portions of the field were attacked by rust. The rust spores came from an adjoining field on the north, and the disease was severest at the outer edge, diminishing in intensity toward the middle of the lot. Plots 1 and 21 were most affected, and plots 11 and 31 were apparently uninjured. A slight attack occurred from the southeast on plots 33 to 40, but it did not seem to affect the yields noticeably. The attacks were not serious in succeeding years, and the plots appeared to recover fully before the close of the experiment.

In April, 1907, before the field was divided into plots, samples of the soil were taken by Mr. Prescott, in accordance with Dr. Brooks' instructions, from each quarter of the field. These samples were analyzed by E. B. Holland and R. D. McLaurin of the department of chemistry. The determinations of the soil constituents were made in solutions obtained with hydrochloric acid, after the methods of the Association of Official Agricultural Chemists.

TABLE I. — *Composition of Soil (Per Cent).*

	SOUTHEAST.			SOUTHWEST.			NORTHEAST.			NORTHWEST.		
	Surface.	First Foot.	Second Foot.	Surface.	First Foot.	Second Foot.	Surface.	First Foot.	Second Foot.	Surface.	First Foot.	Second Foot.
Coarse material above 0.5 millimeter, .	18.97	-	-	13.96	-	-	14.55	-	-	12.95	-	-
Fine earth, ...	81.03	-	-	86.04	-	-	85.45	-	-	87.05	-	-
<i>Analysis of Fine Earth.</i>												
Insoluble matter, ...	89.43	91.012	92.290	89.86	93.321	94.035	90.49	93.307	95.621	90.27	92.842	96.036
Potash (K_2O), ...	.09	.096	.105	.09	.093	.123	.10	.102	.096	.07	.087	.089
Lime (CaO), ...	.20	.080	.070	.22	.135	.097	.23	.060	.061	.22	.036	.059
Magnesia (MgO), ...	.07	.010	.019	.02	.029	.001	.02	.022	.041	.01	.003	.021
Phosphoric acid (P_2O_5), ...	.25	.030	.033	.21	.039	.060	.27	.052	.048	.20	.080	.039
Sulfuric acid (SO_3), ...	.04	-	-	.04	-	-	.04	-	-	.05	-	-
Volatile matter, ...	4.26	2.613	1.881	4.55	2.117	1.175	4.14	2.173	.791	4.25	2.709	.800
Humus, ...	1.97	-	-	1.94	-	-	1.85	-	-	1.78	-	-
Total nitrogen (N), ...	.13	.052	.024	.14	.054	.014	.13	.044	.014	.13	.055	.008

NORTH

1	21
2	22
3	23
4	24
5	25
6	26
7	27
8	28
9	29
10	30
11	31
12	32
13	33
14	34
15	35
16	36
17	37
18	38
19	39
20	40

SOUTH

PLAN OF FIELD

The different samples show a marked uniformity in the percentage of constituents, which are low with the exception of phosphoric acid in the surface soil. This marked proportion of phosphoric acid in the surface soil is not due to the liberal application of phosphatic fertilizers, however. Assuming the surface soil of an acre to weigh 2,000,000 pounds, there are 5,000 pounds of phosphoric acid contained in it. The fertilizers applied to an acre contained approximately 350 pounds. The vegetable matter in the surface soil is probably the means by which the phosphoric acid, lime and nitrogen are accumulated in the surface layer when compared with the lower depths.

There is observable a small difference in the proportion of fine soil in the sample from the southeast quarter, which may in part account for a poorer yield of asparagus from the plots on that area.

The arrangement of the plots is shown in the plan on page 235, and the kinds of fertilizers and the yearly yields of asparagus are given in Table II.

TABLE II. — *Yields per Plot (Pounds).*

Plot.	FERTILIZERS APPLIED.	Pounds.	1909.	1910.	1911.	1912.	1913.	1914.	1915.
1	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	- 6.67 13.00	109.3	229.9	182.2	197.5	310.7	346.4	305.4
2	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	15.56 6.67 13.00	110.8	236.6	212.3	230.6	350.2	406.8	367.2
3	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 6.67 13.00	110.6	256.8	236.8	263.8	386.9	423.5	394.8
4	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	31.12 6.67 13.00	112.3	236.1	226.2	265.5	379.9	413.4	387.5
5	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 - 13.00	115.4	232.3	221.1	270.9	388.0	404.3	382.3
6	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 4.44 13.00	121.4	241.4	221.1	273.4	385.8	420.4	391.3
7	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 6.67 13.00	110.0	241.6	240.8	281.1	387.8	436.9	415.4
8	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 8.89 13.00	123.6	252.8	252.6	298.4	403.3	436.4	412.1
9	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 6.67 -	103.2	208.6	210.6	258.6	324.0	366.7	334.6
10	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 6.67 8.67	117.9	237.2	237.3	284.8	373.6	408.4	387.6
11	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 6.67 13.00	136.1	277.8	290.1	342.1	446.8	478.9	433.9
12	Nitrate of soda, . . . Acid phosphate, . . . Muriate of potash, . . .	23.33 6.67 17.33	126.1	262.7	269.6	302.8	409.8	453.5	417.9

TABLE II. — *Yields per Plot (Pounds)* — Continued.

Plot.	FERTILIZERS APPLIED.	Pounds.	1909.	1910.	1911.	1912.	1913.	1914.	1915.
13	Manure, ... Nitrate of soda, ... Acid phosphate, ... Muriate of potash, ...	1000. — — —	112.1	241.8	274.9	315.6	409.4	440.6	386.1
14	Manure, ... Nitrate of soda, ... Acid phosphate, ... Muriate of potash, ...	1000. 15.56 4.44 8.67	105.8	242.9	287.4	329.0	411.4	431.1	382.6
15	Manure, ... Nitrate of soda, ... Acid phosphate, ... Muriate of potash, ...	1000. 23.33 6.67 13.00	120.4	260.1	291.4	337.4	435.3	453.5	408.2
16	Manure, ... Nitrate of soda, ... Acid phosphate, ... Muriate of potash, ...	1000. 31.12 8.89 17.33	112.9	244.8	273.8	336.4	422.0	438.4	412.1
17	Nitrate of soda, ... Acid phosphate, ... Wood ashes, ...	23.33 6.67 130.00	97.8	204.4	257.9	287.3	372.8	373.5	342.4
18	Nitrate of soda, ... Acid phosphate, ... High-grade sulfate of pot- ash, ...	23.33 6.67 13.00	77.3	181.6	224.1	266.0	327.0	327.1	306.2
19	Nitrate of soda, ... Acid phosphate, ... Low-grade sulfate of pot- ash, ...	23.33 6.67 25.00	84.8	190.5	240.6	276.6	327.3	345.9	305.8
20	Nitrate of soda, ... Acid phosphate, ... Kainit, ...	23.33 6.67 50.00	108.9	223.9	248.2	308.2	375.7	396.7	371.6
21	Manure, ...	1000.	103.3	237.4	191.4	202.9	347.8	373.8	343.1
22	Manure, ... Nitrate of soda (spring), ...	1000. 15.56	100.0	226.2	199.4	216.5	346.2	361.7	339.6
23	Manure, ... Nitrate of soda (summer), ...	1000. 15.56	103.3	247.1	218.0	252.2	378.6	385.5	352.8
24	Manure, ... Nitrate of soda (spring and summer), ...	1000. 15.56	101.4	230.2	223.5	250.2	380.4	387.6	365.6
25	Manure, ... Nitrate of soda (spring), ...	1000. 23.33	103.1	222.2	220.8	273.5	382.1	388.3	365.2
26	Manure, ... Nitrate of soda (summer), ...	1000. 23.33	106.0	213.4	227.4	277.3	393.6	390.4	381.8
27	Manure, ... Nitrate of soda (spring and summer), ...	1000. 23.33	107.1	225.4	225.7	283.8	386.7	413.2	378.9
28	Manure, ... Nitrate of soda (spring), ...	1000. 31.12	102.0	214.1	218.4	273.0	370.4	400.0	376.6
29	Manure, ... Nitrate of soda (summer), ...	1000. 31.12	94.2	187.6	205.3	256.8	353.1	373.3	351.9
30	Manure, ... Nitrate of soda (spring and summer), ...	1000. 31.12	104.3	216.4	233.3	296.3	390.4	423.2	390.1
31	Nitrate of soda (spring), ... Acid phosphate, ... Muriate of potash, ...	15.56 6.67 13.00	117.3	220.9	223.8	272.4	375.1	395.8	370.0

TABLE II. — *Yields per Plot (Pounds)* — Concluded.

Plot.	FERTILIZERS APPLIED.	Pounds.	1909.	1910.	1911.	1912.	1913.	1914.	1915.
32 {	Nitrate of soda (summer),	15.56	115.9	221.3	242.4	284.4	401.6	406.3	374.8
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
33 {	Nitrate of soda (spring and summer), . . .	15.56	101.8	222.6	239.8	291.2	378.4	389.8	372.9
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
34 {	Nitrate of soda (spring), .	23.33	96.4	214.3	240.5	288.0	381.9	378.6	350.8
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
35 {	Nitrate of soda (summer),	23.33	97.6	217.1	247.8	288.9	368.3	368.4	353.7
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
36 {	Nitrate of soda (spring and summer), . . .	23.33	99.6	210.2	224.2	268.5	357.4	362.3	337.0
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
37 {	Nitrate of soda (spring), .	31.12	96.1	193.9	223.3	283.8	345.2	340.9	327.7
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
38 {	Nitrate of soda (summer),	31.12	93.6	196.2	234.9	303.0	367.1	347.4	335.4
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
39 {	Nitrate of soda (spring and summer), . . .	31.12	94.4	214.2	230.7	288.4	358.6	351.7	328.7
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							
40 {	Nitrate of soda, . . .	—	84.0	181.3	202.2	263.4	307.5	314.3	275.1
	Acid phosphate, . . .	6.67							
	Muriate of potash, . .	13.00							

One change was made in the fertilizers in the spring of 1912, when the quantity of acid phosphate was increased so that the low, medium and high amounts were, respectively, 10, 15 and 20 pounds, instead of 4.44, 6.67 and 8.89, as tabulated.

The chemicals were standard high-grade materials, and were analyzed each year to check their guarantees.

Acid phosphate contained 14 per cent soluble and available phosphoric acid. Wood ashes carried slightly more than 5 per cent of potash. The stable manure varied but little from 70 per cent moisture, 0.7 per cent nitrogen, 0.5 per cent phosphoric acid, and 0.7 per cent potash.

The asparagus was cut regularly and prepared for market. The weights were made before the stalks were bunched and trimmed, and the yields therefore include the butts and waste stalks with the marketable crop. No data were secured from which to estimate the probable marketable bunches per plot, but the estimate of practical growers is that the waste involved in preparation for market constitutes about one-fifth of the total weight cut.

The attack of summer rust in 1910 caused the affected plots to produce

less weight in 1911 than in 1910, which is shown clearly by the table. The plots thus affected were Nos. 1 to 10 and 21 to 27. Plots 37 to 40 were somewhat affected without showing it in a depressed yield. The yields for 1914 and 1915 showed a nearly complete recovery from the rust. The percentages of increase of the crops for 1914 over those of 1910 were determined and the recovery was well shown, except in plots 1, 21, 22 and 23, which were most severely affected. The percentages of increase on these plots were, respectively, 51 per cent on plot 1, 57 per cent on plot 21, 59 per cent on plot 22, and 56 per cent on plot 23. On the rest of the plots the majority of percentages of increase ranged between 70 and 80 per cent, with a few above 80 per cent, and the recovery from the rust attack on plots 2 to 10 and plots 24 to 29 was evidently thorough.

The effect of the rust has been considered in comparing the relative effects of different methods of fertilizing the crop, and the yields for the years 1911, 1912 and 1913 have been omitted from the comparisons. The results of the first two years and the last two years are sufficient, however, to give a good view of the effects, since the former serve to show the immediate and the latter the cumulative effects of the fertilizers.

When the crop yields of the different plots are surveyed as a field it will be noted that plots 11, 12, 13, 31, 32 and 33 yielded out of proportion to the rest of the field, and from the plan it will be seen that these plots formed a section across the middle of the field. This persistently high yield could not have been caused by the fertilizers, but was probably due to a slightly greater depth of soil above the underlying gravel, by which the plants had a slightly greater supply of moisture throughout the season.

Plots 3, 7, 11 and 34 were fertilized exactly alike with the medium quantities of nitrogen, phosphoric acid and potash. Plots 21 and 13 received equal amounts of manure with no chemicals. Plots 1 and 40 received medium weights of acid phosphate and muriate of potash without nitrogen. From these plots it can be seen that the western half of the field, including plots 1 to 20, was more productive than the eastern sections, containing plots 21 to 40. The southeastern corner, plots 34 to 40, was the poorest part of the field, all things considered, which may have been due to the slightly coarser character of the soil, as mentioned with the analyses.

Plot 11 has produced the biggest weight of stalks every year, although by no means the most heavily fertilized.

Asparagus is considered to be a hearty feeder, and to require an abundance of plant food to produce profitable results. Three groups of plots were planned to compare graduated amounts of chemical fertilizers. These plots were Nos. 1 to 12. Table II shows the yields. This section was attacked by rust, as already described, but plot 1 alone failed to recover completely from its effects by the year of maximum production, 1914. It is clearly demonstrated that the maximum amounts of fertilizer were of no appreciable effect, and that the medium quantities were ample for a full yield. The actual need of the medium amount of nitrate

of soda indicated by plots 2 and 3 is contradicted by the results from plots 31 and 34 when they are compared in like manner. The soil conditions on the latter plots have been already mentioned and should be taken into account. Its poorer quality may have offset the increased amount of nitrate.

The relative effects of manure and chemicals were compared on plots 13 to 16, and the comparison may also be extended to plots 11 and 12 adjacent to 13. The best interpretation of the results is to say that manure alone and chemicals alone were equally effective, and that the respective quantities of each were sufficient for the soil conditions in producing a crop. There is also no appearance of any cumulative effect of the manure in increasing the crop. The gains of 1914 over 1910 were as follows: plot 11, 72 per cent; plot 12, 74 per cent; plot 13, 82 per cent; plot 15, 74 per cent; plot 16, 79 per cent. This is of interest when one considers the sandy soil and low humus content.

TABLE III. — *Chemicals supplying Nitrogen, Phosphoric Acid and Potash in Connection with Manure (Pounds).*

Plot.	FERTILIZER TREATMENT.	1909.	1910.	1914.	1915.
13	Manure alone, ...	112.1	241.8	440.6	386.1
14	Manure with low chemicals, ...	105.8	242.9	431.1	382.6
15	Manure with medium chemicals, . . .	120.4	260.1	453.5	408.2
16	Manure with high chemicals, ...	112.9	244.8	438.4	412.1
21	Manure alone, ...	103.3	237.4	373.8	343.1
3	Medium chemicals alone, ...	110.6	256.8	423.5	394.8
7	Medium chemicals alone, ...	110.0	241.6	436.9	415.4
11	Medium chemicals alone, ...	136.1	277.8	478.9	433.9
34	Medium chemicals alone, ...	96.4	214.3	378.6	350.8
12	Chemicals high in potash, ...	126.1	262.7	458.5	417.9

Plots 21 to 30, inclusive, were fertilized to determine the value of nitrate of soda as a top-dressing in addition to an application of 10 tons of manure. The value of the added nitrate was rendered questionable by the rust which has been shown to have severely reduced the yields of plot 21 even in 1914, when most plots had apparently recovered. The yield on plot 13, receiving manure alone, was increased 82 per cent in 1914 over the yield in 1910. If the 1910 yield of plot 21 is increased by 75 per cent and compared with the actual yield in 1914 it is seen to be 415 pounds instead of 373.8, which would bring it up to a full equality with the yields of the plots which received nitrate of soda. The economy of the added nitrate is made doubtful.

There were three methods of applying the nitrate of soda, and the results are decidedly in favor of the application in two portions, half in spring and half in summer.

TABLE IV. — *Nitrate of Soda applied at Different Seasons in Addition to Manure (Pounds).*

Manure with Low Application of Nitrate of Soda.

Plot.	SEASON OF APPLYING NITRATE.	1909.	1910.	1914.	1915.
22	Spring, ...	100.0	226.2	361.7	339.6
23	Summer, ...	103.3	247.1	385.5	352.8
24	Half in spring, half in summer, . .	101.4	230.2	387.6	365.6

Manure with Medium Application of Nitrate of Soda.

25	Spring, ...	103.1	222.2	388.3	365.2
26	Summer, ...	106.0	213.4	390.4	381.8
27	Half in spring, half in summer, . .	107.1	225.4	413.2	378.9

Manure with High Application of Nitrate of Soda.

28	Spring, ...	102.0	214.1	400.0	376.6
29	Summer, ...	94.2	187.6	373.3	351.9
30	Half in spring, half in summer, . .	104.3	216.4	423.2	390.1

A similar comparison of different quantities and methods of application of nitrate of soda with chemicals instead of manure was made on plots 31 to 39. The yields on the minimum amount of nitrate were unquestionably superior to those on the higher amounts. It has, however, been pointed out that there seemed to be a lower state of fertility in this corner of the field where the larger quantities of nitrate were used, and that plots 31 and 32 were in a strip of superior fertility. In this series there is a slight advantage in favor of applying the nitrate in the summer at the end of the cutting season, since in four years out of seven each of the summer plots out-yielded slightly the others. The difference is not enough to make it a rule to apply nitrate only in the summer.

TABLE V. — *Effect of applying Nitrate of Soda at Different Seasons in Connection with Fertilizers supplying Phosphoric Acid and Potash (Pounds).**Low Application of Nitrate of Soda.*

Plot.	SEASON OF APPLY- ING NITRATE.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	Aver- age.
31	Spring, . . .	117.3	220.9	223.8	272.4	375.1	395.8	370.0	282.2
32	Summer, . . .	115.9	221.3	242.4	284.4	401.6	406.3	374.8	292.4
33	Half in spring, half in summer.	101.8	222.6	239.8	291.2	378.4	389.8	372.9	285.2

Medium Application of Nitrate of Soda.

34	Spring, . . .	96.4	214.3	240.5	288.0	331.9	378.6	350.8	278.6
35	Summer, . . .	97.6	217.1	247.8	288.9	368.3	368.4	353.7	277.4
36	Half in spring, half in summer.	99.6	210.2	224.2	268.5	357.4	362.3	337.0	265.6

High Application of Nitrate of Soda.

37	Spring, . . .	96.1	193.9	223.3	283.8	345.2	340.9	327.7	258.7
38	Summer, . . .	93.6	196.2	234.9	303.0	367.1	347.4	335.4	268.2
39	Half in spring, half in summer.	94.4	214.2	230.7	288.4	358.6	351.7	328.7	266.7

The inferiority of this corner of the field is clearly indicated by comparing the annual yields of plot 40 with those of plot 1, which was fertilized exactly like it. In the years of no rust plot 1 produced much larger yields than plot 40.

In the comparison of the different forms of potash materials used in fertilizing the asparagus plots 17 to 20, Table II, the first impression would be that muriate was much superior to other forms, and that sulfate was no better than none. A more careful comparison will reveal a close agreement in yields between wood ashes on plot 17, kainit on plot 20, and muriate on plots 34, 35 and 36, all of which received equal amounts of nitrate of soda and acid phosphate. The low yields on plots 18 and 19 were possibly due in part to the proximity of a large oak. The tree was nearer plots 18 and 19 than to any others, but was far enough not to shade the plots until nearly sunset. The extent of its roots in the gravelly subsoil may have been greater than was supposed.

It has been stated that the effects of rust were limited to one-half of the field or less, and that there was a nearly full recovery from the attack as the years passed. This is clearly shown by percentages of losses and gains in yields in Table VI. The first and fourth columns show the losses and gains in yields in 1911 compared with the yields in 1910. It will

be noted that the outside plots 1 and 21 suffered much larger shrinkage than the succeeding plots, and that no injury was apparent after passing the middle of the field. In the second and fifth columns the maximum crop of 1914 was compared with the first full crop cut in 1910, and the percentages of gain are shown to be very much alike after passing the first two or three plots, which were worst affected by rust. The third and last columns show the percentages of shrinkage when the 1915 crop was compared with that of 1914. In general, the percentages are small, and the shrinkages are fairly uniform.

TABLE VI. — *Percentages of Gains and Losses in Different Years.*

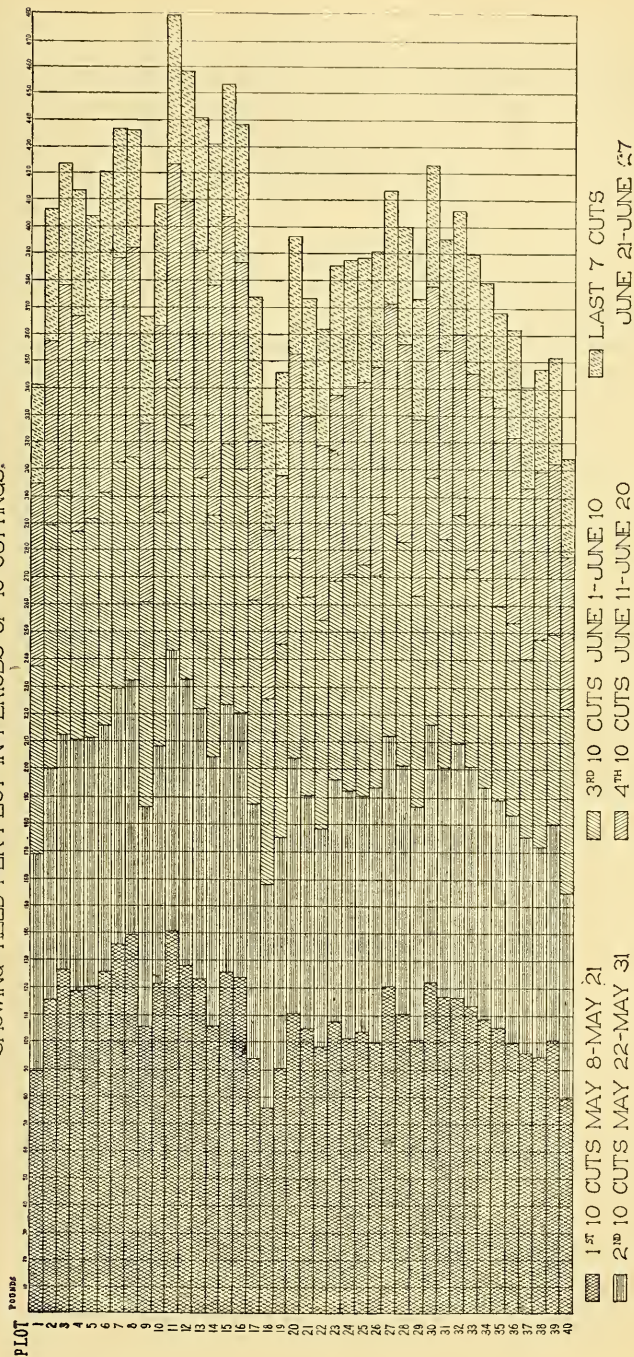
PLOT.	1910 to 1911.	1910 to 1914.	1914 to 1915.	PLOT.	1910 to 1911.	1910 to 1914.	1914 to 1915.
1, . . .	-20	51	-11	21, . . .	-19	57	-8
2, . . .	-11	71	-10	22, . . .	-12	59	-6
3, . . .	-8	65	-7	23, . . .	-12	56	-9
4, . . .	-5	75	-7	24, . . .	-4	68	-6
5, . . .	-5	74	-5	25, . . .	-1	74	-6
6, . . .	-9	74	-7	26, . . .	6	83	-3
7, . . .	-1	80	-5	27, . . .	0	83	-9
8, . . .	0	72	-6	28, . . .	2	86	-6
9, . . .	1	76	-9	29, . . .	9	100	-6
10, . . .	0	72	-6	30, . . .	10	91	-8
11, . . .	5	72	-10	31, . . .	1	79	-7
12, . . .	2	74	-9	32, . . .	9	83	-8
13, . . .	13	82	-12	33, . . .	8	75	-5
14, . . .	18	78	-12	34, . . .	12	76	-8
15, . . .	12	74	-10	35, . . .	14	69	-4
16, . . .	11	79	-6	36, . . .	7	72	-10
17, . . .	26	82	-9	37, . . .	15	76	-4
18, . . .	23	80	-7	38, . . .	19	77	-4
19, . . .	26	81	-13	39, . . .	8	64	-7
20, . . .	11	77	-7	40, . . .	11	73	-12

The question arose in the course of the experiments whether any of the plots produced more early asparagus in proportion to the total crop which might be due to the fertilizers applied. Each year's crop was carefully charted in ten-day periods by Norton for such a comparison. The charts for 1910 and 1914, drawn by R. L. Coffin, are published here, and it will be seen that there were no plots where the first ten days produced proportionally greater weights of stalks compared with other plots than the total crops show. In other words, large yields in the first ten days were followed by continued large yields throughout the season.

FERTILIZER EXPERIMENT WITH ASPARAGUS, CONCORD, 1910.
SHOWING YIELD PER PLOT IN PERIODS OF 10 CUTTINGS.



FERTILIZER EXPERIMENT WITH ASPARAGUS. CONCORD. 1914.
SHOWING YIELD PER PLOT IN PERIODS OF 10 CUTTINGS.



SUMMARY.

A fertilizer experiment with asparagus was conducted for a period of nine years in the town of Concord on coarse, sandy loam, which was typical of the soils used for asparagus culture. Seven crops of young stalks were produced during the experiment, and the yield steadily increased each year until the sixth, which was the crop of maximum size on nearly every plot.

Of the chemical fertilizers used, a mixture of 466 pounds nitrate of soda, 300 pounds acid phosphate, and 260 pounds muriate of potash per acre produced the best yields.

Manure at the rate of 10 tons per acre produced nearly as good results as the chemicals, while combinations of manure with chemicals and with nitrate of soda were no better than manure or chemicals used separately.

There was no apparent cumulative effect produced by the annual use of manure, and the asparagus tops harrowed into the soil each year seemed to supply sufficient organic matter for the efficient use of chemicals.

When nitrate of soda was added to manure it was most efficient when applied in two portions, one in the spring and one in the summer. Nitrate of soda applied with acid phosphate and muriate of potash was slightly more effective when applied in summer in four years out of seven.

Muriate of potash was, on the whole, the most satisfactory potash compound used.

Following the second crop an attack of rust from an adjacent field swept over about half of the plots. The plots nearest the source of the attack were reduced in yield the next season nearly 20 per cent, and were permanently injured. The remainder of the plots apparently recovered before the maximum yield of the sixth crop.

The sixth or maximum crop averaged about 80 per cent greater than the second crop, which was the first full cutting. The seventh crop was less than 10 per cent smaller than the maximum sixth crop.

COMMENTS AND CONCLUSIONS.

WM. P. BROOKS.

Asparagus is an important garden crop in this State, its culture being centered, however, largely in two or three sections: one, and the most important, in Middlesex County, with Concord the most important town; another in Barnstable County, in a number of Cape Cod towns with soils for the most part light; and in several smaller centers, one being on the plain land in Hampden and Hampshire Counties, with the product marketed for the most part in the cities of the Connecticut valley.

My appreciation of the desirability of careful investigations as to the fertilizer needs of the crop, although of earlier date, was stimulated greatly by the outbreak of rust, particularly in the Middlesex and Barnstable sections. The disease was carefully investigated by Dr. George E. Stone, at that time a member of the station staff, and discussed in a number of our publications.¹

The culture of asparagus in the localities mentioned had, previous to the destructive outbreak of rust in 1897 and 1899, as a rule, been highly profitable, and success, while requiring careful and appropriate attention to details, had not been difficult. The outbreak of rust in this State — a disease which appeared nearly simultaneously in some other parts of the country, and which had been known in Europe for a good many years — seemed for a time to threaten the industry. Fortunately the adoption of improved methods — perhaps most important the introduction of more rust-resistant varieties — has greatly reduced the amount of damage from rust, but the increasing difficulties experienced by even the most skillful growers after the serious rust outbreaks of 1897 and 1899 made apparent the need of investigation in the effort to discover methods of prevention or lessening the severity of attacks. Accordingly, by means of visits and correspondence, I sought to learn in considerable detail what were the most usually accepted and followed methods of the best growers.

This effort had been preceded, however, by observations and chemical work based upon results obtained in my home garden. The total weight of shoots of the old variety, Moore's, cut in a good bed 85 feet in length and 6 feet in width, two rows having been set, was at the rate of 15,061 pounds per acre, while the weight of the tops grown after the cutting season, which ended June 18, was at the rate of 14,875 pounds per acre. Both classes of material were carefully sampled and analyzed under the direction of the late Dr. C. A. Goessmann. The shoots were cut from May 2 to June 18, 1901; the tops, just after the first severe frosts, Nov.

¹ For a list of these publications, see the bibliography at the end of this bulletin.

1, 1901. Table I shows the plant-food contents of the spring shoots as cut, of the marketable portion of these shoots, and of the tops grown subsequently to the growing season.¹

TABLE I. — *Amount of Plant-food Elements in Asparagus Shoots and Tops (Pounds per Acre).*

	Shoots cut.	Marketable Shoots, ²	Tops.
Nitrogen, ...	49.5	40.0	54.29
Phosphoric acid, ...	16.2	13.0	11.01
Potash, ...	49.4	40.0	148.80
Lime, ...	—	—	61.00

PLANT FOOD TAKEN FROM THE LAND ANNUALLY.

The amounts of the leading elements of plant food shown in the above table to have been contained in the shoots (in a commercial crop) represent the total of these elements which in the practice of good growers in Massachusetts need be taken into account in determining a system of manuring or fertilizing which will make good to the land the amounts of these elements annually carried off in a large crop, for it is the practice of all our good growers to allow the tops grown after the end of the cutting season to stand during the winter, and to break them down and harrow them into the ground the following spring. The total commercial crop obtained in my garden is probably at least three times the average total obtained by commercial growers. The late Mr. Frank Wheeler of Concord was looked upon by those acquainted with his methods as one of the best informed and most successful asparagus growers in the State. In replying to a communication from me in which I had reported the results obtained in my own garden, Mr. Wheeler writes under date of Sept. 30, 1901:—

In regard to the amount of crop per acre, it seems to me that you have got a very large yield. . . . I shall have to get at my conclusions in regard to the number of pounds of crop removed in the cutting season by partial guesswork. I think that 300 dozen bunches is a liberal estimate of the average of the crops hereabouts. It is too high for the last two years. One dozen should weigh 15 pounds, making 4,500 pounds per acre, plus butts cut off and thrown away, which I think would not exceed 1,000 or 1 500 pounds, equaling 5,500 or 6,000 pounds at the most.

The very large yield which I obtained is doubtless in part accounted for by the fact that the two rows set, though placed only about 3½ feet apart, to some extent fed outside of the 6-foot width, the figure used in computing the area occupied by the bed.

¹ Actual analyses by H. D. Haskins.

² These figures are based upon the estimate of the best growers, to the effect that the butts cut off in preparation of the shoots for market constitute on the average one-fifth of the total weight cut.

THE AMOUNTS OF FERTILIZER USED BY GOOD GROWERS.

In connection with the correspondence with Mr. Frank Wheeler, to which reference has just been made, the question as to whether in the practice of good growers plant food was not applied in quantity much in excess of the amounts which the crop could use was taken up. Upon this point Mr. Wheeler writes as follows:—

It has also struck me very forcibly that we were applying two or three times as much fertilizer material as the crop was taking out, but I never doubted but what it was . . . profitable to do so. I can hardly think that any asparagus bed (commercial) was ever hurt by overmanuring. I have known of a number of old beds destroyed and used for other purposes, and they prove to be most productive for other crops (crops too, that we suppose do not need as much manuring as asparagus) under continued applications of fertility. As to the unsatisfactory results from the asparagus crop for two or three years back, I think very strongly that it was the fault of the rust, and cold seasons of 1900 and 1901.

Although I agree with you most decidedly that the growth of the previous summer is a good indication of what the crop is to be, I do feel most strongly that a liberal application (not excessive) of nitrate of soda in the early spring is profitable. Of course you know that the first growth that any plant makes in the spring is feeding root fibers. Now do you think that they are for only taking up moisture? I feel they are for both moisture and food. I think that an asparagus plant (one year old) when set out will start off much stronger if set out in good rich soil than if set in sand or a poor one, or any other plant or seed will do the same. I have no doubt but what some of the early application of nitrate of soda is lost, but think it is still profitable. I know of no experiments to prove either for or against this conclusion.

Mr. Wheeler wrote that as the result of earlier experiments and observations it was his practice in asparagus growing to supply from 200 to 250 pounds of actual potash per acre annually. Table II shows the total amounts of plant food applied annually in Mr. Wheeler's practice, and in the second column (taken from Table I) the amounts annually carried off in the asparagus as bunched. These elements were derived in part from manure and wood ashes, but mainly from tankage, nitrate of soda and muriate of potash.

TABLE II. — *Amount of Plant-food Elements supplied and removed (Pounds per Acre).*

	Supplied.	Removed in Marketable Asparagus. ¹
Nitrogen, ...	125	40
Phosphoric acid, ...	100	13
Potash, ...	200-250	40

¹ It seems to me proper, in considering plant food removed, to take into account only the asparagus as bunched, because the butts cut off in the preparation of the shoots for market might be returned to the bed at the close of the cutting season at a negligible cost, practically speaking.

The figures in Table II will suggest to every thoughtful reader the question as to whether the practice of good growers as exemplified by that of Mr. Wheeler does not furnish a very much greater amount of the different leading plant-food elements than can be necessary, and therefore whether the net profits of asparagus growing would not probably be increased by some reduction in the amount of fertilizer applied. In the case of the element nitrogen no large accumulation in the soil as a result of excess application is likely, but if the generally accepted conclusions relative to the relations of phosphoric acid and potash to the soil are correct, the practice under discussion must in a series of years mean a large accumulation of these elements in the soil.

PLAN OF THE HOME FERTILIZER EXPERIMENT.

The fertilizer investigations with asparagus upon the home grounds were laid out in 1903; those in Concord were, with the exception of a few minor details, a duplicate of the home experiment.¹ It seems desirable, therefore, to make a clear and full statement of the principal questions upon which it was hoped light would be thrown by these experiments. The preceding paragraphs, taken together with the quotations from the correspondence with the late Frank Wheeler, will, it is thought, sufficiently indicate my reasons for the particular inquiries taken up, namely:—

1. To test the question as to the amounts of the different elements of plant food, all in the form of chemicals, which can be employed with advantage.
2. To test the question as to how much, if any, fertilizer can be used with advantage in connection with manure.
3. To determine what difference, if any, there is in value between the different materials which may be used as a source of potash.
4. To determine whether nitrate of soda used in connection with manure is beneficial, what quantity, if any, it pays to use, and whether it should be put on in the summer (that is, at the close of the cutting season), in the spring, or equally divided between the two seasons.
5. To determine the same points with reference to the use of nitrate of soda in connection with chemical fertilizers supplying phosphoric acid and potash.

THE CONCORD INVESTIGATIONS.

In 1907, in submitting to Dr. True, then of the Office of Experiment Stations, an outline of the investigations with asparagus in view in Concord as an investigation under the Adams act, the following brief statement (in substance) was made. Two general objects are in view:—

1. An effort will be made to breed more rust-resistant types of asparagus. This investigation was undertaken in co-operation with the Bureau of Plant Industry at the head of which at that time was Dr. B. W. Galloway.

¹ The plan of the Concord experiment, and, further, a statement of the fertilizing materials applied to the several plots, is found in Table II under the "Description of the Experiment."

2. To determine the principles which should underlie practice in the use of fertilizers for asparagus. This investigation is to include not only the most varied applications of plant-food elements as to kind, quantity, forms of combination and season of application, but studies as well of effects of the varied treatments upon: (1) the characteristics of the soil, — physical, chemical and biological; and (2) the plant as influencing the character of its development, its physiology and its health.

Breeding Investigations. — The co-operative breeding experiments were from the first under the direct charge of Dr. J. B. Norton of the Bureau of Plant Industry.¹ It is generally held by the majority of those who have examined the breeding grounds in Concord, and tried the better of the new varieties produced, that his work has been attended with a large measure of success. The better varieties are all designated by the class name "Washington," which was the name given to the male plant which, having given the best results in comparative crosses made, was chosen for most of the breeding work. Several of the varieties of this class produced seem to combine a large measure of capacity to resist rust with desirable commercial characteristics.

A number of plants of some of these varieties have been distributed by this Experiment Station to asparagus growers in different parts of the State for trial as compared with older varieties. A considerable number of reports have been received, but since the earliest distributions were made in 1915 it is yet too early for decision as to the rank which these varieties will finally take among those cultivated by Massachusetts growers. It may be said, however, at this point that the majority of those reporting have expressed favorable opinions. There have been some who have thought the new varieties which they had under trial were hardly equal to the best older varieties, while others have reported that they could see no particular difference in ability to resist rust.

Fertilizer Investigations. — In a statement of the plan of research proposed, submitted to Dr. True for approval under the Adams act, it was stated to be the plan to study the results of the variant fertilizer treatments from two points of view in addition to the apparent direct effect upon the yield; namely, as above stated, first, the characteristics of the soil; and second, those of the plant. Various conditions affecting the possibilities for investigational work in the Station have prevented giving much attention to the study of the effects upon the soil, most important among them being changes in the personnel of the chemical and microbiological staffs. The second line of investigation, however, — namely, the effects upon the plant, — has engaged considerable attention. The investigations along this line have been under the direct charge of Professor Morse, and for the most part conducted by him. The leading results of these investigations have been reported in a number of different papers.²

¹ Dr. Norton has reported the results of his work in publications which are listed in the bibliography.

² For a list of these papers, see the bibliography.

My conclusions as to the significance of the results obtained from year to year, as well as many details of the experiment, including the general description of the soil and its preparation, have been presented in the annual reports referred to in the bibliography and in addresses at annual conventions of the Massachusetts Asparagus Growers' Association. It seems advisable to present these conclusions here, and for the sake of completeness I include also conclusions based upon observations on points not considered in the description of the experiment:—

1. In the year 1910 a late frost considerably reduced the yield of shoots as cut. The cutting season of 1910, moreover, was characterized by low average temperature. For these reasons, the total cut of 1910 was undoubtedly less than normal; nevertheless, even greater emphasis might well be placed on the effect of rust on a portion of the plots than has been done in the discussion.

2. The medium amounts of the different fertilizers furnishing the leading plant-food elements applied have furnished the maximum amounts of these elements which prove useful to the crop as indicated by yields produced.

3. The oak tree which stood near the northeast corner of the experiment field exercised an adverse influence upon the yields of some two or three plots, including those to which sulfates of potash had been applied for comparison with muriate used on plots in other parts of the field. While the plots referred to were not actually shaded by the tree, there can be no doubt that some of its roots extended a short distance into these plots, for it is generally recognized that as a rule the roots of trees which stand in the open extend outward from the trunk in every direction a considerable distance beyond the tips of the branches. The adverse influence of these roots was clearly shown in the inferior growth of the tops after the close of the cutting season.

However, muriate of potash appears to be the best form in which to supply that element, this conclusion being based not alone upon the results obtained in the series of experiments under discussion, but in large measure upon results obtained in much longer-continued comparisons of muriate of potash with sulfates under conditions, so far as can be judged, absolutely fair to the comparison of these two forms of potash.¹

THE HUMUS CONTENT OF THE SOIL IN ASPARAGUS GROWING.

In the discussion of the experiment particular attention is called to the fact that the continuous application of manure in this series of experiments with asparagus did not appear to exercise a cumulative effect on the humus content of the soil favorable to satisfactory production, and mention is made of the practice of our commercial asparagus growers of allowing the tops grown subsequently to the end of the cutting season to

¹ These results have been referred to repeatedly in annual reports, especially those discussing results obtained with asparagus on Field B on the home grounds. For references to details, consult indexes of annual reports for 1906-17 (nineteenth to thirtieth).

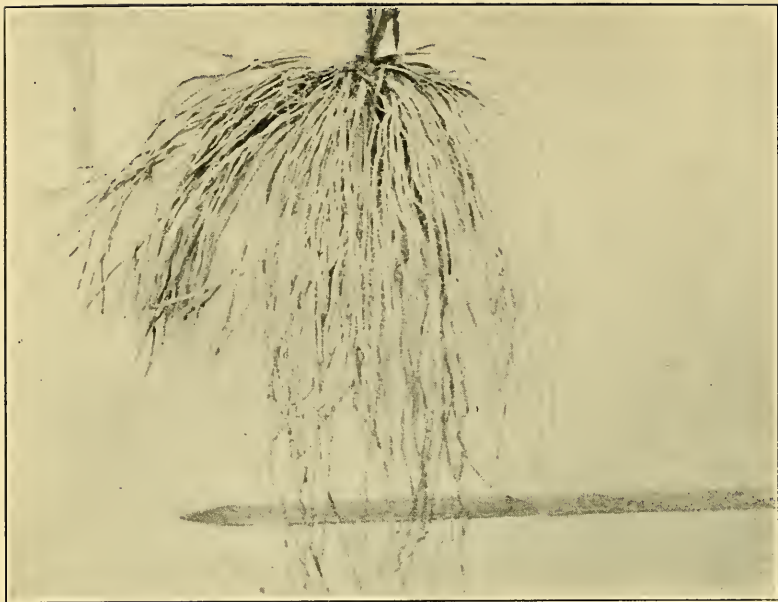


FIG. 1. — Root system of three-year-old asparagus plant taken November 7. Average length about 4 feet, a few of the roots 5 feet 6 inches in length.

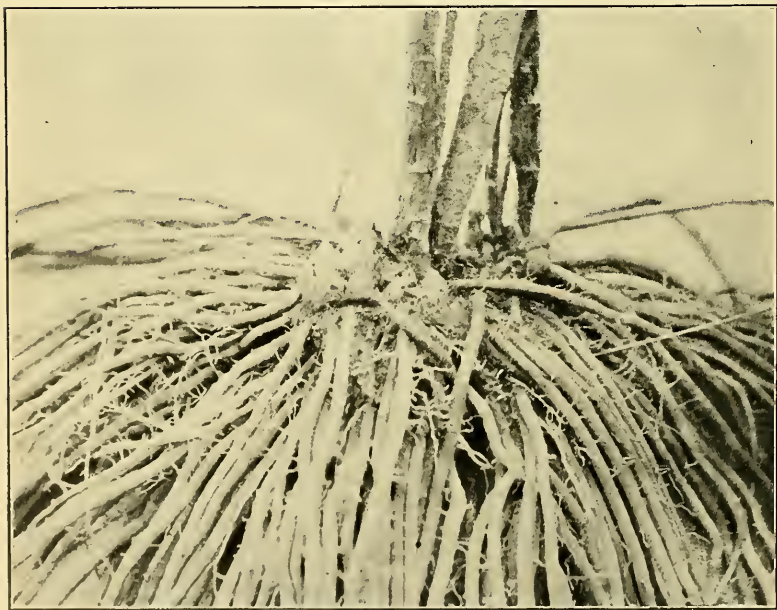


FIG. 2. — Shows crown and a part of the root system of three-year-old asparagus plant dug and photographed November 7. Weight of roots and crown as dug about 6 pounds, and estimated that the portion separated from the soil and weighed constituted only about three-fourths of the entire root system.

remain in the field to be harrowed under the following spring as perhaps accounting for the fact that there was no apparent favorable effect of manure as compared with chemicals which could be attributed to a greater supply of humus. There can be no doubt that the practice of harrowing in the tops is fully justified by results, both because of its relation to humus content and the lesser removal from the bed of plant-food constituents.

I would, moreover, call attention to a peculiarity in the growth of asparagus which I believe to be also an important factor in accounting for the apparent non-beneficial effect of continued use of manure as a source of humus. As is well known, the thick roots and the crowns of asparagus plants serve an important function in the economy of the plant as storage reservoirs for reserve materials which are drawn upon heavily in the production of the spring shoots which constitute the commercial crop. The root system is a very large one. Some of its peculiarities are clearly shown in Figs. 1 and 2. It will be noticed that there is a very large number of crowded, rather thick roots, and that these roots in the plants which have made only three years' growth — one in the seed bed and two after setting — have already attained a great length, and in the aggregate make up a heavy weight. The photographs from which the illustrations were made were taken by the late Mr. C. W. Prescott from one of the roots dug up for purposes of chemical examination, the results of which are reported in Bulletin No. 171. The roots just referred to were taken up in 1908. Another lot of roots was taken up for chemical examination in 1910, and no photographs were taken of any of the roots taken up at the later date. The different roots show considerable variation in total weight and other characters, but on the average were but little, if any, longer, more numerous or heavier than those shown in the illustration. Among the second lot of roots were found some evidently older roots which were hollow and inactive, having undergone partial decay. The conclusion to be drawn from this observation, strongly supported by analogies afforded by well-known facts concerning the life histories of a large number of other plants, both cultivated and wild, is that the root as a rule serves for storage perhaps only a single year, then becomes inactive, dies and decays in the ground. This is true, for example, of Solomon's seal, false Solomon's seal, sarsaparilla and numerous other plants. An analogy is afforded also by the familiar habit of numerous bulbous plants as, for example, the crocus, tulip, hyacinth, gladiolus, etc. There can be no doubt that this constant replacement of older roots by new, the older then decaying, contributed largely to the humus content of the soil, and would seem, therefore, to be a highly important consideration in accounting for the lack of favorable influence of manure on the humus content of asparagus beds.

THE RELATION OF VARIATIONS IN FERTILIZER APPLICATION TO RUST.

In the brief statement of the objects in view in the fertilizer experiment, already given, occurred the phrase: "... to include ... studies ... of effects of the varied treatments upon: ... (2) the plant as influencing the character of its development, its physiology and its health."

In this brief reference I had in mind particularly any influence upon the extent of injury from rust, which at the time the experiments were planned was the only disease of asparagus which was proving at all serious. This line of investigation was suggested by the fact that numerous investigators had become convinced, as a result of their studies, that variations in the kinds, amounts, and perhaps also in the seasons of application, of chemical fertilizers had an important relation to the capacity of different cultivated plants to resist disease. One of the earliest in this country to believe this, both from his study of results obtained through the experience of others and from experiments conducted by himself, was the late Dr. C. A. Goessmann, who became convinced that peach yellows could be prevented by suitable applications of potash.¹

It is not possible to demonstrate by means of figures showing the yields of commercial asparagus in the experiments in Concord that such variations in fertilizer treatment as were made in those experiments either did or did not affect the amount of rust. The principal reason why this is true is because the attacks of rust were determined chiefly by the location of plots both as to direction and distance from sources of infection, — in other words, from fields of the old and highly susceptible varieties of asparagus found in various parts of the district in Concord in which our experiments were located. It was impossible, therefore, to measure in figures any difference which might have been caused by variations in fertilizer treatment.

My conclusion, however, based upon frequent examinations of the growth, especially subsequent to the end of the cutting season when the tops and foliage were developing or fully developed, was that there was no influence on the amount of rust that could be attributed to a difference in the kind of chemicals used in the experiments. On the other hand, my examination of the plots — most important, the one made in late September in 1911, the year of the heaviest infestation of rust — led to the conclusion that variation in the time of application of the nitrate of soda did have considerable effect. At my request Mr. J. B. Norton, who saw the bed much more frequently than I, made a particular point of attempting to trace any effect of rust due to variation in fertilizer treatment. Mr. Norton, working entirely independently and without knowing what differences if any I had noticed, agreed with me almost absolutely as to relative amounts of rust on different plots. Our conclusion was

¹ Agriculture of Massachusetts, 1881, p. 84; 1882, p. 440; 1883, p. 360.

that the application of at least a portion of the nitrate of soda at the close of the cutting season reduced the amount of rust. It seemed to both of us, also, to be true that there was less rust where all the nitrate was reserved and applied at the end of the cutting season than when only one-half was so reserved and applied. In conclusion on this point, this then is the only effect of the wide variations in fertilizer treatment upon the health of the plants which can be confidently stated.

CONCLUSIONS.

The more important conclusions having either direct practical or scientific importance which the investigations reported in this bulletin appear to warrant may be stated as follows:—

1. The variety of asparagus and the location of the bed with reference to badly infected beds which may be sources of infection influence susceptibility to rust and probability of bad attacks to a greater extent than variations in manurial or fertilizer treatment.

2. A number of the varieties produced in the co-operative breeding experiments conducted in Concord appear to have to an exceptional degree the character of relative immunity from rust. The best of these are from crosses with a superior male plant found in a bed of Giant Argenteuil.

3. In commercial asparagus growing as usually carried on in this State it is a common practice to apply what appear to be excessive quantities of fertilizers.

4. The medium amounts of the several plant-food constituents applied in these experiments appear to have furnished the different leading elements of plant food in as large quantities as could be utilized by the crop.

5. These medium amounts are at the following rates per acre:—

	Pounds.
Nitrate of soda, ...	460
Acid phosphate, ...	300
Muriate of potash, ...	260

6. Nitrate of soda at the rate of about 400 pounds per acre in connection with manure at the rate of 10 tons per acre increased the crop, and appears to be the maximum amount which proved beneficial.

7. Among the different materials employed for the purpose of furnishing potash, the muriate, everything considered, proved most satisfactory.

8. The application of either acid phosphate or muriate of potash with manure at the rate of 10 tons per acre appears not to have increased the crop.

9. The immediate or even the cumulative effect of yearly applications of manure in increasing the humus content of the soil does not appear to have been beneficial; in other words, chemical fertilizers upon this sandy soil give as good results as manure.

10. The lack of benefit which can be attributed to humus furnished by the manure may be explained in part by the practice of our commercial asparagus growers in allowing the tops grown subsequent to the cutting season to remain on the ground to be worked into the soil the following spring.

11. The conclusion appears to be justified; through observations upon the root habit of the asparagus, that yearly replacement of roots used when relatively young for the storage of reserve material by younger roots is also an important factor in accounting for the lack of beneficial effects resulting from humus furnished by manure. The roots thus replaced decay, thus adding to the organic matter of the soil.

12. The season of application of nitrate of soda does not appear to affect the relative yield of commercial asparagus in successive ten-day periods throughout the season; in other words, the cut of commercial asparagus during the early part of the season is not increased by either small or large applications of nitrate made as early as the soil can be worked.

13. The season of application of nitrate of soda does appear to influence the susceptibility of asparagus to rust, which I am convinced is reduced by the application of at least a portion of the nitrate of soda at the close of the cutting season.

14. The character of the season, especially the amount and distribution of rainfall, appears to affect the probability of a serious attack of rust to a considerable degree, such attacks being more common in dry seasons than in those characterized by normal or abundant and well-distributed rainfall.

BIBLIOGRAPHY.

Asparagus Breeding.

- J. B. NORTON. Methods used in breeding Asparagus for Rust Resistance. Bureau of Plant Industry, Bul. No. 263.
— Washington Asparagus. Bureau of Plant Industry, Cotton, Truck and Forage Crop Disease, Circ. No. 7.

Asparagus, Chemical Study of.

- F. W. MORSE. Soluble Carbohydrates in Asparagus Roots. Mass. Agr. Expt. Sta. Ann. Rept. 23, Pt. I, p. 135.
— Effects of Fertilizers on Asparagus Roots. Mass. Agr. Expt. Sta. Ann. Rept. 25, Pt. I, p. 154.
— A Chemical Study of the Asparagus Plant. Mass. Agr. Expt. Sta. Bul. No. 171.

Asparagus, Fertilizer Experiments.

- W. P. BROOKS. Reports of the Asparagus Substation. In Mass. Agr. Expt. Sta. Ann. Repts. 20, p. 15; 21, Pt. II, p. 27; 22, Pt. I, p. 26; 23, Pt. I, p. 24; 24, Pt. I, p. 25; 26, Pt. I, p. 24a; 28, Pt. I, p. 16a; 29, Pt. I, p. 23a.

Asparagus Rust.

- G. E. STONE. The Asparagus Rust in Massachusetts. Hatch Expt. Sta. Bul. No. 61.
— Discussion of Asparagus Rust. In Hatch Expt. Sta. Ann. Repts. 9, p. 72; 10, p. 58; 12, p. 61; 14, p. 69; Mass. Agr. Expt. Sta. Ann. Rept. 20, p. 126.

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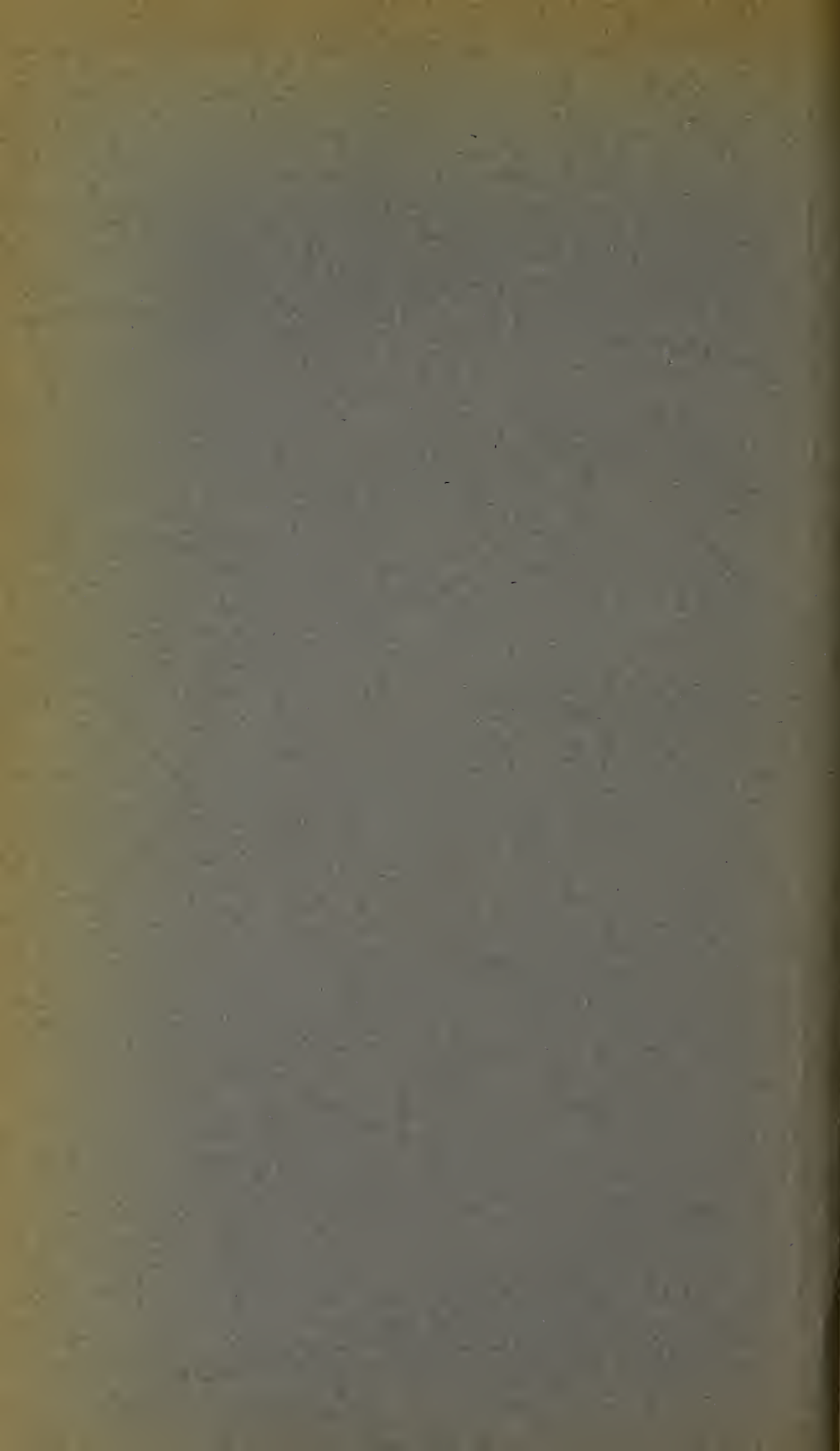
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MASSACHUSETTS
AGRICULTURAL COLLEGE
—
REPORT
OF
THE EXTENSION SERVICE



1919



MASSACHUSETTS AGRICULTURAL COLLEGE

THE FIFTY-SEVENTH ANNUAL REPORT OF THE
MASSACHUSETTS AGRICULTURAL
COLLEGE

PART V.—THE REPORT OF THE EXTENSION
SERVICE FOR THE YEAR ENDED
NOVEMBER 30, 1919



PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

The Commonwealth of Massachusetts

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Oct. 1, 1920.

To His Excellency CALVIN COOLIDGE.

SIR: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith, to Your Excellency and the Honorable Council, Part V of the fifty-seventh annual report of the trustees, this being the annual report of the Extension Service for the year ended Nov. 30, 1919.

I am, very respectfully, your obedient servant,

KENYON L. BUTTERFIELD,

President.

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MASSACHUSETTS AGRICULTURAL COLLEGE! EXTENSION SERVICE.

ORGANIZATION FOR 1919.

TRUSTEES' COMMITTEE ON EXTENSION SERVICE.

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NATHANIEL I. BOWDITCH, Framingham.
JOHN F. GANNON, Worcester.

Member Ex Officio.

President KENYON L. BUTTERFIELD, Amherst.

THE EXTENSION SERVICE STAFF.

WILLIAM D. HURD,¹ *Director of the Extension Service*.
RALPH W. REDMAN, *Acting Director of the Extension Service*.
L. WAYNE ARNY, *Supervisor of Correspondence Courses and Extension Editor*.
WILLIAM R. COLE, *Extension Specialist in Food Preservation*.
LAURA COMSTOCK, *Leader of County Home Demonstration Agents*.
ROY B. COOLEY, *Extension Specialist in Animal Husbandry*.
ABRAM L. DEANE,² *Assistant Supervisor of Junior Extension Work*.
GEORGE L. FARLEY, *Supervisor of Junior Extension Work*.
LAURA GIFFORD, *Extension Specialist in Nutrition and Household Management*.
HENRY E. HASLETT, *Extension Specialist in Sheep Husbandry*.
WILLIAM F. HOWE, *Assistant Supervisor of Junior Extension Work*.
DELOS L. JAMES, *Extension Specialist in Dairying*.
EARL JONES, *Extension Specialist in Agronomy*.
WILLIAM C. MONAHAN, *Extension Specialist in Poultry Husbandry*.
EZRA L. MORGAN, *Extension Specialist in Community Planning*.
EARL H. NODINE,³ *Assistant Supervisor of Junior Extension Work*.
HELEN M. NORRIS, *Assistant Supervisor of Junior Extension Work*.
SUMNER R. PARKER, *State Leader of County Agricultural Agents*.
RUTH S. REED, *Extension Specialist in Clothing Efficiency*.
RALPH A. VANMETER, *Extension Specialist in Pomology*.
JOHN D. ZINK, *Supervisor of Exhibits and Extension Schools*.
JOHN D. WILLARD, *Extension Specialist in Co-operation and Marketing*.

HEADS OF DEPARTMENTS DEVOTING PART TIME TO EXTENSION WORK.

ALEXANDER E. CANCE, *Professor of Agricultural Economics*.
WALTER W. CHENOWETH, *Professor of Horticultural Manufactures*.
JAMES A. FOORD, *Professor of Farm Administration*.
JOHN C. GRAHAM, *Professor of Poultry Husbandry*.
CHARLES R. GREEN, *Librarian of the College*.
WILLIAM P. B. LOCKWOOD, *Professor of Dairying*.
FRED C. SEARS, *Professor of Pomology*.
FRANK A. WAUGH, *Professor of Landscape Gardening*.

¹ Resigned May 1, 1919.

² Resigned Sept. 14, 1919.

³ Appointed Sept. 11, 1919.

CLERICAL STAFF.

- JESSIE M. PRINCE, *Chief Clerk, Extension Service.*
HELEN E. PHILLIPS, *Clerk, Junior Extension Service.*
MARGARET G. DAVIDSON, *Clerk, Extension Service.*
GRACE E. GALLOND, *Clerk, Department of Dairying.*
CATHERINE A. HARRINGTON, *Clerk, Department of Agricultural Economics.*
KATHERINE GARDNER, *Clerk, Division of Agriculture.*
HONORIA A. LEE, *Clerk, Division of Horticulture.*
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SUSAN L. CLARK, *Clerk, Extension Service.*
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MARION E. HAWTHORNE, *Clerk, Extension Service.*
LAURA H. SABIN, *Clerk, Division of Agriculture.*
ELLEN L. WELCH, *Clerk, Division of Science.*
CLARA A. SWIFT, *Clerk, Extension Service.*

ANNUAL REPORT OF THE EXTENSION SERVICE

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

THE SCOPE OF THE EXTENSION SERVICE.

The Extension Service is the whole State College of Agriculture functioning in an educational way for those who are not resident students at the institution.

To set at work practical knowledge of agriculture and home economics is the work of the Extension Service. Sound methods of agricultural practice, tested by the Experiment Station and developed by the resident college faculty, are demonstrated to farmers of the State by the Extension Service specialists through the co-operation of the farm bureaus. Household management, food utilization and clothing efficiency are taught in the same way by the home demonstration specialists.

Through the Extension Service the College of Agriculture is carried to the farms and the homes of the State so that farmers and farmers' families may find agriculture more profitable and life more satisfactory. This work of dissemination is jointly furthered by the Massachusetts Agricultural College, the United States Department of Agriculture and the county farm bureaus.

THE FARM BUREAUS.

The county farm bureaus are local organizations through which the Extension Service specialists reach farmers, and form the chief means by which contact is maintained between the sources of agricultural investigation and those who put the information to work on the farms and in the homes of the State. Every agricultural county has a farm bureau organization.

URBAN AS WELL AS RURAL SERVICE.

The college has much for the city dweller as well as for the farmer, and it is the part of the Extension Service to make available the resources of the college to the people of the State. The Agricultural College is the food supply college of the State. Those whom it serves are all who eat. To-day it takes up matters of distribution, of financing, of retailing, of utilizing products, as well as matters of production. Food is needed for 4,000,000 every day in the Commonwealth, and it must be of suitable quality and at attainable prices. Problems of marketing and of nutrition have commanded the attention of departments of the Extension Service. During and immediately after the war food conservation was taught on a scale and with an effectiveness never before possible. This work was a benefit to urban as well as to rural residents, and was made possible only through the hearty co-operation of the local farm bureaus and civic organizations.

Much of this work, however, has either been stopped or sharply curtailed since the war by the withdrawal of necessary funds. Unfortunately a part of the work that had been undertaken prior to the war, and which is as necessary in peace as in war, was also left without financial provision. The war emergency work was financed by the United States Department of Agriculture, which appropriated nearly \$175,000 for the use of the Extension Service in stimulating conservation and production in this Commonwealth.

When this sum was reduced to the normal \$20,000 a year from the Federal government, several important projects had to be discontinued. Despite this enforced limitation of the scope of the Extension Service, more than half a million people were reached during the year by demonstrations, exhibits, lectures, conferences and personal farm and home visits of specialists and county agents.

FEDERAL SUPPORT.

The Federal government purposes to support only a nucleus of the State-wide organization for Extension education, and expects the State and counties to provide for the financing of whatever further expenses are necessary to the efficiency of

Extension work. In Massachusetts much Extension work has always been supported by the Massachusetts Agricultural College since its establishment in 1867. In 1909, five years before Federal aid for Extension work was available, the college had met such a persistent demand for field work in the State that it was obliged to organize an Extension Service with full-time instructors for the carrying of sound agricultural information to farmers of the State. The Co-operative Extension Act, passed by Congress in 1914, and known as the Smith-Lever Act, brought some additional money to the work, and provided a stimulus for the completion of the Extension Service organization.

ADMINISTRATION.

The Extension Service constitutes one of the three main divisions of the Massachusetts Agricultural College. Its administration is vested in a director, who is responsible to the president of the college. He is paid by the college from funds originating within the State, but he is the official representative of the United States Department of Agriculture in the supervision of co-operative Extension work in agriculture and home economics.

The director is assisted in his administrative work by an assistant director, who is a specialist in Extension methods and administration; by a State leader of agricultural projects; by a State leader of boys' and girls' club work; and by a State leader of home demonstration.

On Dec. 1, 1919, the college became a part of the State Department of Education by the act which consolidated many State boards and departments into not more than twenty major departments.

RELATIONS WITH COUNTY ORGANIZATIONS.

During the year much progress has been made in effecting closer relationships with the farm bureaus. A more effective use of the college specialists has been made by the farm bureau workers, due in part to a better understanding, and in part to a more extensive use of the project system for conducting Extension work.

Under the Massachusetts law providing for the appointment

of trustees for county aid to agriculture, effective May 31, 1918, the work formerly undertaken by the county farm bureau corporations has been transferred to the control of public boards of trustees. These are appointed by the county commissioners. The old farm bureau organizations are continued quite actively in some counties and are dormant in others. The public trustees now employ the county agents and are responsible for their work. The funds of the farm bureau corporations are turned over to the public trustees and are paid as a part of public funds. Both organizations are still currently known as farm bureaus.

County schools for agriculture are maintained in the counties of Essex, Norfolk and Bristol. These schools employ, co-operatively with the college and the Federal government, agents in agriculture and home economics, and they are all developing departments to function as farm bureaus.

CHANGES IN STAFF.

Two-thirds of the members of the staff as of Dec. 1, 1918, resigned during the year, and it has been impossible to fill their places with equally competent specialists except at salaries a thousand dollars or more above the former level.

The almost-universal reason for resignations has been markedly better salaries elsewhere. Not only do other educational institutions outbid Massachusetts for her trained specialists, but commercial concerns find successful Extension workers valuable in many positions, and have taken members of the staff at salaries of \$1,500 to \$4,000 more than the college could pay.

Director William D. Hurd resigned May 1, 1919, to join the soil improvement committee of the National Fertilizer Association. He had had charge of the Extension work for ten years, and to his untiring effort much credit is due. Work for the remainder of the year was in charge of Acting Director R. W. Redman, as the director-elect, John D. Willard, was unable to leave his duties with the State Commission on the Necessaries of Life until late in the winter of 1919-20.

On Dec. 1, 1919, only 20 per cent of the Extension specialists had been with the college a full year. Since it requires from six months to a year for an Extension specialist to become familiar

with conditions in the State, this means that the college is continually breaking in a new staff of specialists. Such frequent changes are not only a very real handicap to the Extension work, but they cost the State more than would salaries adequate to retain trained specialists.

Lack of funds has made it impossible to fill some positions, and there are now nine staff vacancies, with resignations occurring every few weeks. At the same time, salaries paid county agents by the county organizations have considerably increased. The maximum salary paid a county worker is \$6,000. There have been many changes, however, in the county farm bureaus as well as at the college. The qualifications required for Extension work, both in physical endurance and expert knowledge, make it impossible to secure desirable workers at salaries paid one, two and three years ago.

CLERICAL CHANGES.

Clerical assistants, too, have changed so frequently as to interfere with the effectiveness of the specialists' work. Many times stenographers do not stay long enough to become thoroughly familiar with the subject-matter work of their departments. Untrained girls have found the Extension Service an excellent experience school for attractive positions; and under the present salary limits experienced clerks and secretaries, who are so essential to efficient administration, cannot be expected to stay. In spite of many changes, however, there has been a fine spirit in the clerical staff, and under the training of Assistant Director Redman both the quality and the quantity of the work have been commendable. Standard practices have been developed and have brought increased effectiveness in office work.

EXTENSION NEEDS.

The Extension Service is young. New fields of activity invite its attention at every hand, but it is compelled by lack of resources to limit its effectiveness.

The Extension worker hears the call of the small towns of Massachusetts that have dwindled to a fraction of their former populations. Their problem is simple to state, but not simple to answer. It did not pay as well to stay in them as it did to

leave; so the people left. The agriculture of these small towns can be revived only if it can be proved profitable. This is a problem of the Extension Service.

In an urban and a suburban Commonwealth the facilities of the Extension Service must reach to the flower bed and the back-yard poultry flock of every home. With an annual food bill of about \$750,000,000, Massachusetts produces only 10 to 15 per cent of her food. This percentage can be greatly increased if home owners can be more generally interested in raising the more bulky and expensive commodities, — vegetables, fruit, milk and eggs. Correspondence courses now reaching 750 people a year, teaching agriculture and home economics by mail from the teaching department of the college, could easily be increased manyfold and be made many times more effective if sufficient help were available to handle the work.

PROJECTS.

The report by projects on the following pages includes the work of both Extension specialists and county agents. It is impossible to separate the reports of the two groups, for college Extension staff and county staffs have worked jointly to make the projects effective.

All projects were in some degree supported by State funds. The following projects were supported solely by State funds: —

13. Library Extension.
15. Correspondence Courses.
16. Lectures.
17. Exhibits.
20. Co-operation and Marketing.
28. Extension Courses at the College.
31. Soils and Crops.

The following projects were supported in part by Smith-Lever funds: —

1. Administration.
- 1a. Printing and Distribution of Publications.
2. County Agricultural Agents.
3. Home Economics.
4. Extension Schools.
5. Junior Extension Work.
8. Pomology.

9. Animal Husbandry.
10. Farm Management Demonstration.
11. Poultry Husbandry.
12. Dairying.
24. Sheep Husbandry.
25. Plant Diseases.
29. Horticultural Manufactures and Food Preservation.
30. Vegetable Gardening.

The following projects were supported in part by funds received from the United States Department of Agriculture:—

2. County Agricultural Agents.
3. Home Economics.
5. Junior Extension Work.
10. Farm Management Demonstration.
24. Sheep Husbandry.
29. Horticultural Manufactures and Food Preservation.

AGRICULTURE.

The Extension Service has co-operated in establishing demonstrations on farms about the State for purposes of illustrating the results to be expected from methods advocated by the college. This very practical form of teaching has been made possible through the interest of progressive farmers and by the cordial support of the farm bureaus. Live-stock farms, pastures, mowings and hundreds of acres in potatoes, corn, soy beans and grains have been utilized as visible examples of the value of agricultural improvement and experimentation.

Soils and Crops.

Potatoes. — Demonstrations with potatoes to show the superiority of northern-grown "seed" over home-grown "seed" formed the most important crop work of the year. Seventy demonstrations gave an average excess production for northern-grown seed of 79 bushels to the acre. Russet and Green Mountain seed were also compared, but the prevalence of rot interfered with the demonstrations, and they will be repeated. The Russet seed proved more productive of marketable potatoes on the results secured.

Soy Beans. — Using the glue method of inoculation, 145 acres of soy beans were planted on 123 demonstration farms, and the

results were good. The soy bean is becoming increasingly popular as a companion crop with corn for silage, the legume increasing both the feeding value of the silage and the fertility of the soil.

Corn Variety Tests. — Corn variety tests were conducted in seven counties to secure varieties, both for grain and for the silo, that will mature in the different parts of the State. The crop from demonstration farms has formed a significant feature of farm bureau exhibits at county fairs.

Rosen Rye. — The supply of seed of Rosen rye is now sufficient so that any grower in the State can easily secure it. Tried on 231 acres of 55 farms, it has yielded an average increase over other varieties of 6 bushels an acre.

Clover and Alfalfa. — Fifty-eight farmers were assisted in establishing demonstration fields of clover, and forty-two were assisted in starting alfalfa. Clover acreage is still far below what it should be in Massachusetts because of lack of knowledge of its value and of methods of growing it. Although definite demonstrations with alfalfa are fewer than in former years, more farmers every year are successfully growing this valuable legume.

Pastures. — The increased value of milk and live-stock products has added interest in the demonstrations that have been conducted in the improvement of pastures. In three counties acid phosphate and lime have been used to bring back white clover and other forage grasses. The results in the added value of the pasturage thus treated have been so marked that the demonstrations will probably be extended. In Berkshire County wild thyme has been treated with various chemicals in attempts to control this noxious pasture weed.

Top Dressing Mowings. — Eighteen demonstrations in top dressing hay were conducted in four counties, and showed substantial returns for the application of available nitrogen.

Fruit and Fruit By-Products.

Orchard Tours. — Orchard tours, on which organized automobile parties of growers accompany the county agent and fruit specialists through demonstration orchards during the application of advised methods of management, were introduced as

part of the fruit project during the growing season, and met with enthusiastic approval by the growers. The orchard owner and the specialist provide the instruction and tell the story of the orchard practice, answering questions with actual results.

Demonstration Orchards. — The demonstration orchards, conducted by farmers co-operating with the college, have become more generally used as meeting places for orchardists in the last year, and have been the assembling ground for many conferences with the specialist and with the county agent. In several counties team work in orchard pruning and spraying has been organized, groups of growers working with the county agent or specialist long enough to develop the best method for the work.

Storage. — There are under construction or contemplated about twenty apple-storage cellars, some of which are simply the reconstruction of existing cellars into satisfactory storage. Interest in large co-operative storage has been manifested in one or two sections, and will doubtless develop. In those districts where retail trade for fruit has been established, the farmer is particularly interested in maintaining a supply over a long period.

By-Products Manufacturing. — Massachusetts has done pioneer work in horticultural manufactures the past few years. In utilizing hitherto waste apples and other fruits, for jellies, apple butter, sterilized fruit juices and canned products, and in promoting the preservation of such products with a minimum of sugar, the Extension specialist in this new field made possible the salvaging of thousands of dollars' worth of valuable farm products which are universally grown. Prof. W. W. Chenoweth has done both original research work in perfecting manufacturing processes and effective Extension work in arousing interest and organizing the dissemination of his methods. He has introduced many rural and suburban housewives to undiscovered delicacies from the hitherto wasted unmarketable product of garden and orchard.

Two by-products factories have been organized, one in Hampden and one in Franklin counties, and one new community center canning kitchen was organized.

Poultry.

Farm Demonstrations. — Farm demonstrations are promising subjects for community programs. The few demonstrations conducted this year showed no labor income of less than \$2,000 on the farms on which records were completed. Cockerel's futurity testing demonstrations have been accepted by some of the most progressive poultrymen as a method of applying what scientific information is available on the inheritance of fecundity.

Culling Campaign. — State-wide campaigns were conducted in poultry culling and in the better feeding of poultry. In 82 culling demonstrations before 1,517 persons, 10,000 birds were handled in teaching methods of culling non-layers from the flocks.

Early Hatching Campaign. — So general was the response to the campaign for early hatching that poultrymen all over the State have commented on the unusual number of early matured pullets and the absence of late summer hatches. More than 60 commercial breeders co-operated.

Berkshire County Farm and Town Egg-laying Contest. — The energetic organization of poultrymen achieved in Berkshire County by the new Berkshire County Poultry Association, which was formed to promote standard bred poultry, started its initial enterprise in November, when it undertook a farm and town egg-laying contest with forty contestants.

Live Stock.

Pure-bred Sire Campaign. — In co-operation with the Bureau of Animal Industry in Washington, D. C., the Extension Service started, on October 1, to wage war against the scrub sire in all farm stock. The crusade has received the active co-operation of several of the farm bureaus, and has an enrollment of 143 live-stock owners, who have pledged themselves to use only pure-bred sires in all their stock breeding.

A considerable increase in the pure-bred stock kept through the State is already noticeable. In changing from scrub to pure-bred sires farmers have desired pure-bred cows and sows also, and secured the assistance of county agents last year in pro-

curing 82 pure-bred cows, as well as 66 bulls and 31 boars. The members of the campaign pledge themselves to use no males not passed upon by a regional committee as to purity of breed. It is a mission that is fast growing, and will continue to spread.

A start has been made in reorganizing the cow-test associations started before the war, all of which were discontinued because of the enlistment of their managers in the military service. Definite dairy improvement is assured through these cow-testing associations, whose members agree to weigh and test their milk regularly to determine how profitable is each of their cows.

Sheep Demonstrations. — In the hill and pasture sections of the State seven economic sheep management demonstrations have been conducted to show the possibilities for increased sheep production in Massachusetts. Two very successful wool marketing associations were formed, which brought the farmers \$3,200 in increased returns over what they would have received had they sold their product individually.

Dairying.

Milk Advertising Campaign. — Producers and dealers of milk joined with civic organizations, the State Department of Agriculture, the United States Department of Agriculture, and the college in a milk advertising campaign to encourage the use of milk and its products. This campaign was financed by a contribution from producers and dealers of three-fourths cents per 100 pounds, and an extensive campaign of newspaper advertising, posters, talks and display literature was undertaken, with results that more than justified the expense and labor. Milk squads of school children, firemen, factory employees, clerks, letter carriers and newsboys were formed, all members promising to drink a quart of milk a day for three months. Doctors and clinics assisted in valuable research work, and a valid demonstration was obtained.

Milk Plants. — During the year three new central milk plants were assisted with technical advice as to machinery, building plans and business organization from the Extension Service.

Farm Management.

Account Books. — Since farm account books have been necessary to the making out of income tax returns, their use has greatly increased. During 1919, 743 farm account books were distributed, and 160 of these were found by a partial canvass to have been used in full. The summarizing of these accounts should supply much valuable data.

Farm Management Tours. — The farm management tour, developed to study the proper balance of enterprises on the farm, was undertaken in three counties this year, and the results of the tours seem to indicate that it is the most effective method of demonstrating to farmers the importance of good management. The farm management demonstrator and county agent together analyzed the business of several farms in each county. Before these were visited on the tour, charts and neostyled copies were prepared for the farmer members, and as each farm was inspected the owner explained his management and answered questions.

Cost of Milk Production. — Members of the county staffs and of the Extension Service have been called upon again to assist in the collection of data from farmers on the cost of milk production. The previous work in collecting these data made the task comparatively simple, and further improvement is expected in the method of obtaining such data another year.

Co-operation and Marketing.

Co-operative Purchasing Associations. — Assistance was given co-operative purchasing associations in business methods and market information.

Farmers' Community Retail Markets. — The markets in operation this year were in many cases so successful that both producers and consumers demanded their continuance during the winter months. Assistance was given committees in organizing farmers' retail markets. The most successful markets have been those in Springfield, Boston, Quincy, Cambridge, Holyoke, Haverhill, Pittsfield and Northampton.

Farmers' Wholesale Produce Markets. — Plans have been drawn up for the reorganization and development of farmers'

wholesale produce markets in at least five of the larger cities, and preliminary steps for reorganization have been started in Lawrence and Springfield.

Producers' Milk Plants. — There has been a persistent demand for assistance in the organization of farmers' co-operative milk plants. Eleven cities interested in the undertaking have received attention from the Extension Service, co-operating in some cases with a representative of the United States Bureau of Markets. The Westfield Co-operative Milk Plant was organized during the year with up-to-date processing equipment.

Fruit Growers' Exchanges. — So exceptionally strong was the market for fruit that the fruit growers' exchanges asked little assistance in finding markets. Six of the exchanges were aided in solving problems of transportation, grading and market information.

Market Gardeners. — Special attention was given to local market news service in western Massachusetts, Worcester and Boston, while some help was given the market gardeners of Holyoke, Haverhill, Boston and Worcester.

Tobacco Growers' Warehousing and Selling Organizations. — During the year tobacco growers' warehousing and selling organizations were formed in Hampshire and Hampden counties. They have secured buildings and promise to be successful.

Wool Marketing Exchanges. — Co-operating with the sheep specialist, wool marketing associations were incorporated at Pittsfield and Shelburne Falls, the members of both averaging 11 cents a pound net gain over the prices paid individuals outside the associations.

Market News Service. — In Springfield and Worcester a successful market news service has been organized for the benefit of local producers, dealers and consumers. The Springfield news service report is collected and arranged daily by an agent of the Hampden County Improvement League, and is circulated in the two local papers which serve also western Massachusetts towns. The report covers wholesale and retail prices of fruits and vegetables on the Springfield markets. A similar news service is conducted by a member of the Worcester County Farm Bureau.

Through the co-operative effort of the Hampshire and Franklin County Farm Bureaus and the Extension Service a special

market news service bulletin on the daily carload movement of onions from the Connecticut Valley is being issued for the growers and dealers of the valley.

HOME ECONOMICS.

Nutrition.

Through Extension schools, study groups and local training classes, as well as in specialized campaigns, emphasis was given the need for hot school lunches and the use of more milk. Regular study groups were instructed in the properly filled and packed lunch box. Superintendents, teachers and trustees of schools were advised in regard to equipment and preparation for serving school lunches.

The home demonstration specialists co-operated with the dairy program for milk advertising by lectures, exhibits and demonstrations to such groups as parent-teacher associations, granges, mothers' clubs, Red Cross chapters and Girl Scouts. Many foreign mothers were helped by visits to their homes and demonstrations in their own kitchens. Definite increases in the consumption of milk, especially by children, have resulted in many communities.

Preservation.

Four counties held training classes for local leaders and had the class members can their products under supervision. Five community kitchens were organized in the counties where women reported that much food was being wasted for lack of help in canning. Thousands of homes are known to have followed the directions presented by specialists and home demonstration agents through the various local women's clubs and organizations.

With the demand for education in food preservation somewhat diminished after the war, correspondence to a considerable extent replaced demonstrations. Advocating the use of a minimum amount of sugar in preserving, the specialists prepared thousands of women to deal with the sugar shortage by a modification of their recipes.

Clothing Efficiency.

The clothing specialist, through an organization effected by the county and State home demonstration agents, trained both beginners and advanced demonstration groups. Classes were limited to ten workers, with as many observers as could be accommodated. Such a demand was found for this work that careful planning was required to meet it. The great Extension feature of the group method is that each member of the small class was trained to pass along the lesson to one other person, who in turn passed it on. Thus the instruction spread through ever-widening circles.

Follow-up groups were formed in every instance with a project leader who received monthly quizzes and suggestions from the specialist. The 472 women who were originally taught by the specialist passed on the instruction to 1,855 women for the entire course, and to 1,637 women for part of the course. It was reported that 1,878 families adopted suggestions from this instruction. Mrs. Reed has carried forward this unique work by the personal contact method, and she has won a firm hold on all of her disciples, having built a self-propagating organization for clothing efficiency that is fast reaching the less accessible farm women of the State.

Millinery.

Six counties and one city organized and carried on work in millinery much after the pattern of the clothing efficiency work. Essex County especially achieved excellent results from diligent efforts.

Household Management.

Kitchen arrangement, equipment and the keeping of household accounts were taught by slides, lectures, charts showing convenient kitchens, and by displays of home-made appliances.

Special emphasis was given to account work during the year because of government interest and because of many requests from home-makers for help in keeping accounts. The account book, prepared after consultation with many women and inspection of many accounts, is not unlike the farm account book used in farm management. Three editions, in all 3,000 books,

were needed to meet the demand. Demonstrations in the keeping of accounts, in the planning of meals, in the food budget and in analysis of market orders were given before many women's organizations. The project is as yet incomplete, but it has been most favorably received.

Health.

Home demonstration agents in nine counties and two cities organized health centers, dental clinics and toothbrush and fly campaigns, working in co-operation with the State Department of Health, as there has been no Extension specialist in this project. Dental clinics in four counties have aroused widespread interest because of their effective and salutary work, and neighboring communities have adopted the plan. The illustrative material of the farm bureaus has been frequently used by schools in pushing the fly and toothbrush campaigns.

JUNIOR EXTENSION.

The aim in Junior Extension during 1919 has been to maintain enough interest among all the club members to carry them through to the completion of their projects. Less effort was made to obtain large enrollments. "Banner clubs" of those who complete all requirements increased in number during the year.

Careful planning was necessary to maintain this interest. Regular meetings were held. The program was developed to cover two or three years, so that none should lose in enthusiasm by enforced repetition. Judging teams were chosen to demonstrate at various exhibits the proficiency of the club members. Inter-town and inter-city contests were held to select the county champions, and then inter-county contests decided the State teams. The State winners entered the Eastern States Exposition as the representatives of Massachusetts, and there won 11 out of 22 first prizes.

Prize Money.

Additional money for use in club work was furnished by the generosity of the Department of Agriculture and of the Massachusetts Society for the Promotion of Agriculture. The De-

partment added \$1,000 to its previous donation of \$2,000, and the society gave \$2,500 for club work, of which \$1,300 was distributed among the counties, and the remainder used to bring prize winners to the Eastern States Exposition. In Middlesex County the \$100 share was used to send 42 prize winners in club work to the Massachusetts Agricultural College for two days. In Berkshire County a one-year dairy cow contest was started with the contribution. In Barnstable County 25 young people were invited to spend the day at the annual meeting of the boys' and girls' section of the farm bureau. Other money was used for local prizes.

Camp Week at M. A. C.

Following a new plan in awarding prizes, all boys' and girls' club prize winners were given a week at the Massachusetts Agricultural College. The camp had a daily attendance of 85, eight of the prize winners coming from the islands south of the Cape, on what was for several their first trip to the mainland. A program of education as well as play was provided on the campus, and the results of the brief training won the hearty support of many parents for the farm bureau and Extension activities. Eight State champions were given a trip to Washington with the money contributed by the Department of Agriculture.

The Clubs.

Club work was carried on in home economics, canning, pig raising, poultry, calf raising and home gardening.

Under home economics club leaders, bread making, sewing and cooking were taught. Over half the club leaders had been domestic science teachers, and many of the rest were grade teachers or mothers. Most of the leaders had a practical knowledge of their work, but one-day training schools were held to develop in them an understanding of club methods. There were 2,513 members in the clubs at the start, and 70 per cent finished. It is interesting to note that 210 boys enrolled in these clubs. In Salem there were two bread clubs made up entirely of boys, 12 in each club, while in Norfolk County a boy held the county record, baking 288 loaves of bread in 28 days.

Canning clubs enrolled 1,300, less than the membership during the war; but the smaller number enabled the clubs to work for uniformly high-quality products.

Pig clubs had 1,300 members, who exhibited their pigs at county fairs and at field days for club members. Accounts were kept by all members through the year.

Three egg-laying contests were held for the poultry clubs, the spring contest proving the most popular. There were 52 clubs with 1,000 members. Many home visits were made, and much time was devoted to the training of teams for judging at fairs and at the Eastern States Exposition.

Calf clubs were a new project and were given considerable time. Club members were required to have either pure-bred bulls or grade-heifer calves, and experienced unusual difficulty in getting them. Agents of the State Department of Agriculture helped in securing the pure-bred stock, while some of the State farm superintendents gave club members the first chance at calves from their herds. One of the boys who won first prize on his calf at exhibits at Worcester and Springfield started his live-stock career raising rabbits, and with his rabbit returns bought his calf. Three little Polish girls bought three pure-bred calves for \$75 each, and during the year won \$90 prize money.

Home garden clubs interested city and suburban children almost exclusively, and all were helped by the home garden primer. One of the boys won \$75 in prize money on his produce, and one girl sold \$45 worth of flowers.

EXTENSION SCHOOLS.

Eighteen Extension schools were held in eight counties, with 666 people enrolled. The schools are organized by local committees, and are conducted jointly by the farm bureaus and Extension Service. Demonstration and teaching methods are adapted to an intensive course in whatever subjects the local people desire. Results of such schools are difficult to analyze. Often the local committees are more satisfied with the benefits received than are the specialists, who necessarily compare such teaching with the regular follow-up work and personal contact they maintain in their other demonstration activities. It is intended to operate these schools hereafter only where follow-up work of a definite nature is possible.

Tractor Schools.

Five tractor schools were held in as many counties during the year, at which the operation, care and repair of tractors were taught.

One-day Meetings.

One-day meetings were held under the auspices of the farm bureaus, usually in series and dealing with related subjects most applicable to the community needs. They proved valuable in furthering definite programs of work.

Exhibits.

An itinerant exhibit managed by the Extension Service and accompanied by members of the Extension staff was shown at 9 of the larger fairs of the State. These fairs had an aggregate attendance of 455,300, of whom it was estimated 57,560 inspected the college exhibit, or 2,306 persons a day for the 25 days of the fairs. Charts and models setting forth the advantages of growing legumes, the value of pure-bred sires and other methods of farm practice and of home-making were prepared under the supervisor of exhibits, who spent much of the summer and early fall in this work.

The farm bureaus in 10 counties displayed material furnished by the college at 56 fairs, where they estimated 206,000 people inspected the exhibits.

At the union agricultural meetings in Boston exhibits on Junior Extension work and on horticulture were so successful that they brought advance reservations of additional space for 1920.

Poultry exhibits were displayed at poultry shows, showing disease treatment and culling. These received uniformly favorable comment on their effectiveness.

SHORT COURSES.

The Extension Service is responsible for vocational and professional training courses at the college lasting not more than one week. Of these brief courses the summer and winter farmer's week programs and the training schools in horticultural manufacture were the most important the past year.

Farmers' Week. — The winter farmers' week has attracted many general farmers from the near-by counties, and some specialists from more distant parts of the State. This year, however, was the first time that a summer farmers' week had been attempted in Massachusetts. It was so distinctly successful that it has become a permanent part of the year's Extension program.

Hundreds of farmers and their families enjoyed to the fullest the opportunity given by a week of exceptional weather to inspect the college equipment. They were shown the field demonstrations, with the crops at the height of the growing season, and were able to appreciate as they had not before the application of agricultural theory to farm operations. More than 2,000 persons attended, and the leading producers' organizations of the State used the facilities offered by the college to hold their annual meetings on the campus during farmers' week.

Winter farmers' week was held in March, as in previous years, and consisted of lectures, demonstrations and exhibits. Difficulties of transportation at that season limited the attendance largely to near-by farmers.

Horticultural Manufacturers' Schools. — Lectures and demonstrations in canning and food preservation were given to three series of training schools. The first was a four-day school, attended by 26 home demonstration agents and their assistants. It was the most satisfactory of the schools, and had a good influence on the work of the summer in the counties. Two-day schools for city leaders were held through May and June, with the attendance at each school limited to 10. Early in September an enthusiastic group of workers from State institutions attended a four-day school in canning and preserving, to prepare for fall preserving at their own institutions.

Landscape Gardening.

Extension work in landscape gardening has been practically suspended during the year because of war-time activities of the workers. Steps have been taken to supply the requests for advice in town planning and private landscape work. Lectures and exhibits have been given in communities and before clubs requesting assistance.

Library Extension Work.

The college library loans books, on request, to libraries in small towns about the State for use of correspondence course students or for study groups, agricultural or home economics clubs, and other interested readers. By applying for them, any person can have college library books loaned him through his local library. In 12 counties during the year, 369 volumes and 29 pamphlets were so loaned.

CORRESPONDENCE COURSES.

The Extension Service offers correspondence courses in agriculture and in home economics to those residents of the State who desire standard outlines of study in these subjects, and who are unable to undertake resident college work. The courses are prepared by members of the teaching departments, who also furnish instruction, while personal contact is maintained with the students by a supervisor of correspondence courses.

Those who enroll in the correspondence courses are, besides farmers, interested rural and suburban home gardeners and home-makers, and prospective agriculturists who look to the college to help them in a new enterprise. Last year the enrollment was nearly 800, a figure that could easily have been much larger had there been resources to provide for a great volume of correspondence. Inadequate finances have not only prevented the addition of new courses which have been much in demand, but have made it impossible to secure needed revision of courses written several years ago.

It is hoped that many of the courses may soon be revised and that more attention may soon be given to the personal progress of the correspondence students. The supervisor of correspondence courses has hitherto been also the Extension editor. It is now proposed to separate these two widely different branches of Extension work and have a full-time supervisor for home study work. No more direct and effective method of carrying the resources of the college to the interested citizens of the Commonwealth has been devised. It is a department of Extension Service worthy of development for greater service.

PRINTING AND PUBLICITY.

The exceptional volume of printed material published during the war made it unnecessary to issue many bulletins or leaflets during the past year. News letters were sent to newspapers, county farm bureau papers and to some farm journals and trade papers as occasion warranted.

Through the office of the Extension editor it is intended to provide adequate news of Extension Service activities and of practical information for weekly and daily newspapers of the State. Frequent technical articles by Extension specialists are sent to the press as well as to the farm bureau papers. It has proved abundantly feasible to disseminate emergency agricultural information, such as advocated remedies for girdled fruit trees, measures for the control of the corn borer, rations for laying hens and planting tables for the back-yard gardener, by the co-operation of the press. Articles on various features of Extension work have also been frequently used by large and small dailies, with a consequently widened field of Extension Service usefulness.

Trade papers, house organs and farm journals, as well as some newspapers, have applied for news and technical information for their readers, and attempts are made to meet all demands. Thousands of readers can be given a recipe for cheap dishes or instructions for building a storage cellar through news columns who would not be reached by lectures or demonstrations. It is very largely through publicity channels that the Extension Service makes its first contacts with the urban and suburban home gardeners and home-makers.

GRAPHIC REPORT.

STATISTICS OF WORK IN VARIOUS PROJECTS.

EXTENSION SERVICE TO MEN, WOMEN AND CHILDREN OF MASSACHUSETTS FROM
Nov. 30, 1918, TO Nov. 30, 1919.

The Massachusetts Agricultural College, the county farm bureaus, and the
United States Department of Agriculture co-operated in this work.

Specialized work in —	Contacts with People (Work started or accomplished).
County Agent Work, ...	82,933
Demonstrations on farms of seed selection, treatment, disease prevention, pruning, variety tests, farm management, animal husbandry, poultry husbandry, use of fertilizers, manures, cover crops, etc.	
Home Economics, ...	71,465
Organization, food, school lunch, preservation, child welfare, clothing, household management, household accounts, exhibits, health, Extension schools.	
Extension Schools, ...	666
Junior Extension Work, ...	44,392
Total enrollments in the various projects:—	
Corn, ... 76	Market garden, 1,346
Potato, ... 195	Poultry, ... 1,014
Home garden, 35,127	Pig, ... 1,231
Canning, ... 2,756	Calf, ... 111
Pomology, ...	Onion, ... 23
Demonstration orchards, Extension schools (specialist returned from army August 1).	
Animal Husbandry, covers State.	
Pure-bred sire campaign, dairy cattle improvement, cow-testing association, cost of milk production, assistance to valley tobacco growers, stock-judging contests, field days, economic swine management demonstrations, live-stock sales.	
Farm Management Demonstrations, ...	3,773
Business farming, — account books, cost of production work, organization of business for year-around work, rearrangement of field lines to facilitate the larger use of farm machinery.	
Poultry Husbandry, ...	6,220
Early hatching, culling slackers, economical feeding, economical management, cockerel futurity tests, fattening and killing.	
Dairying, covers State.	
Advertising use of milk as food.	
Library Work, 28 libraries.	
369 volumes, 29 pamphlets.	
Correspondence Courses, ...	410
Exhibits, ...	263,535
65 fairs.	
Co-operation and Marketing, 128 organizations.	
Co-operative purchasing associations, farmers' community retail markets, producers' milk plants, fruit growers' exchanges, market-gardeners' associations, tobacco growers' warehousing and selling organizations, sheep breeders' wool selling exchanges, market news service.	

	Contacts with People (Work started or accomplished) .
Sheep Husbandry, ...	5,651
Wool marketing associations, lectures, conferences, demonstrations, post-mortem examinations, worm treatment, docking, castrating, shearing, farm visits, farm management demonstrations, pure-bred rams.	
Extension Courses at the College, ...	2,200
Summer farmers' week.	
Horticultural Manufactures, ...	1,161
Apple storage, canning and drying, by-products, manufacturing, home storage, community center organization, market and equipment investigation, State institution horticultural survey, exhibits.	



